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Specializes Manganese Steel

Historic Firm Successfully Turns from Production of Car Wheels and Axles to Casting Manganese Steel—Melts Ferromanganese in Cupola for Converter Steel—Also Employs Electric Furnace

BY H. E. DILLER

HISTORICALLY little has been written of the foundries of this country for few companies now in the foundry business have been in existence long enough to build up extended records of changes and achievements. Many companies making castings have been organized in recent years and few were in existence before the Civil war. Therefore, before describing the operations of the foundry of the Taylor-Wharton Iron & Steel Co., High Bridge, N. J. it will be of interest to review establishment and operation of this company and the succession of changes made necessary by changing industrial conditions. Had research and improvement been neglected, the company could not have maintained its standing in the face of modern competition and industrial evolution. The company dates back to Colonial days, when in 1742 Messrs. Allen and Turner organized the business as a result of the early discoveries of iron ore in the neighborhood of what is now High Bridge. The major portion of the output at first consisted of shoes for oxen, horses and mules, wagon irons, nails and crude farming implements. Since those early days the character of the product and the methods of production have changed many times in keeping with the demand for new commodities. Some kinds of material have been made at High Bridge for every war in which the country has been engaged, from the crude, cast cannon balls of the early day to manganese steel helmets of the late war.

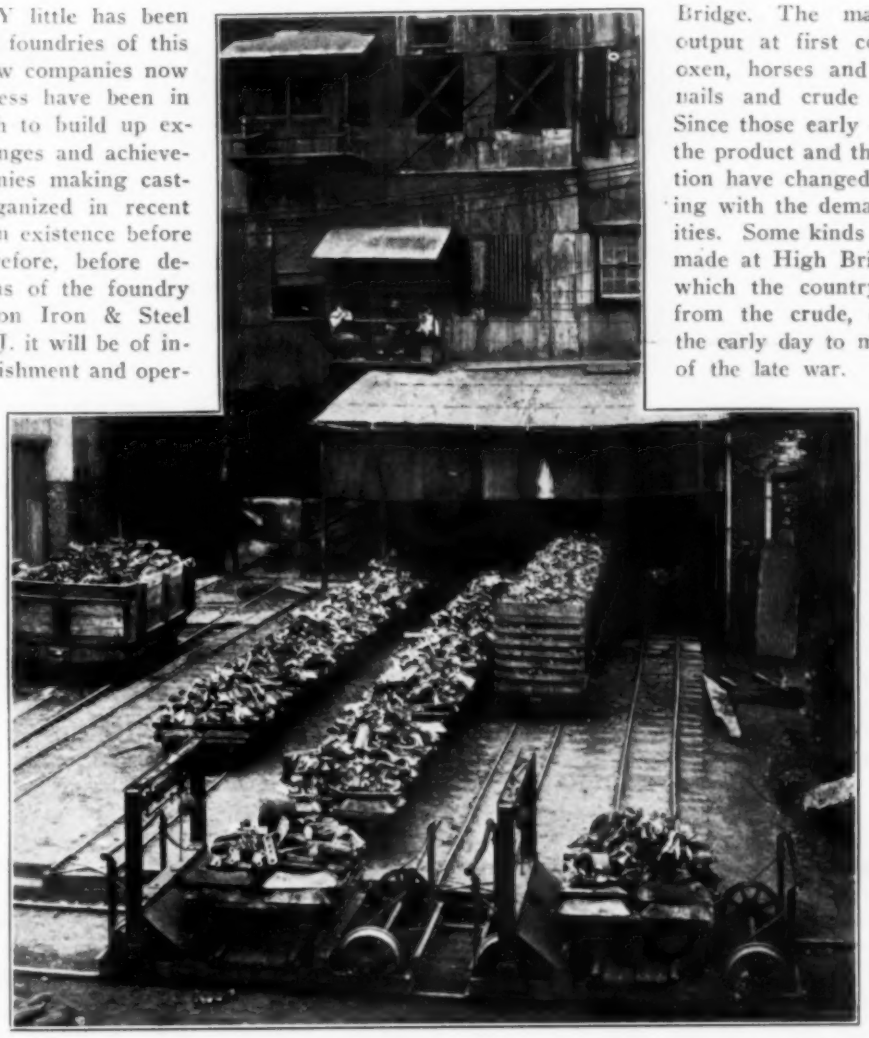


FIG. 1—CUPOLA CHARGES ARE WEIGHED ON SCALE CARS WHICH CARRY BUGGIES TO THE STOCK PILES

Rather unusual, too, in the history of manufacturing firms in this country is long continued association of families and employes with the company. Ever since the beginning of operation when Robert Taylor was employed to manage the works, nearly 200 years ago, either he or one of his descendants have been actively connected with the control of the organization. At present the fifth generation of this family is represented by Percival Chrystie, president. Not only is the control of

the company in the hands of the descendants from the first general manager, but a number of families have been represented by more than one generation in the employ of the company. Four persons are now in the employ of the company who are of the third generation to be associated with various units of the Taylor-Wharton organization. The harmonious relations which the company maintains with its employes is indicated by the fact that a number of men have been employed with the company for more than 50 years and many more are near the 50-year mark.

In expanding to meet new conditions and demands the company at different times acquired control of other companies and now owns the Philadelphia Roll & Machine Co., and the Tioga Steel & Iron Co., both of Philadelphia, and William Wharton, Jr., & Co., Inc., Easton, Pa. The latter company serves as an outlet for a large percentage of the manganese steel castings which are produced at the foundry at High Bridge, the shop with which this article deals.

Thirty years ago the company's chief product was car wheels and axles, but the management was not entirely satisfied with the cast-iron wheel. Henry M. Howe, the noted metallurgist was consulted in regard to securing a better metal for the production of car wheels. Dr. Howe believed in the possibilities of manganese steel for this purpose, and together with William J. Taylor visited Sir Robert Hadfield in England, and arranged for the production of manganese steel in America. Although the properties of manganese steel would indicate it to be an ideal metal for car wheels, experimentation and trial showed that it would not serve for this purpose, and the idea was abandoned. Effort then was made to find a suitable use for this alloy. Several other uses such as in jaws for rock crushers and mine car wheels shortly were developed. Then William Wharton, Jr. & Co. found use for manganese steel castings in their track work. This formed a bond between the Wharton company and the company at High Bridge, then known as the Taylor Iron & Steel Co. and the two companies were merged into the Taylor-Wharton Iron & Steel Co., under which name it now operates.

Many problems had to be solved in the melting, treating and use of manganese steel and the company had the benefit of the metallurgical knowledge and experience of Dr. Howe in developing this alloy. At present the metallurgical work of the company is under the direction of another noted metallurgist, John Howe Hall. That Mr. Hall's metallurgical achievements are generally recognzed is indicated by the fact that recently the J. H. Whiting medal was awarded Mr. Hall for outstanding achievements in the metallurgy of steel casting's production as announced in the FOUNDRY, Aug. 15. One of Mr. Hall's contributions to the manganese steel casting industry is the process of melting ferromanganese in the cupola without an excess loss by oxidation. The application of this method to the production of manganese steel will be better understood when the description of the foundry at High Bridge is noted.

The steel foundry with its many auxiliary buildings is situated about a mile from the center of the small town of

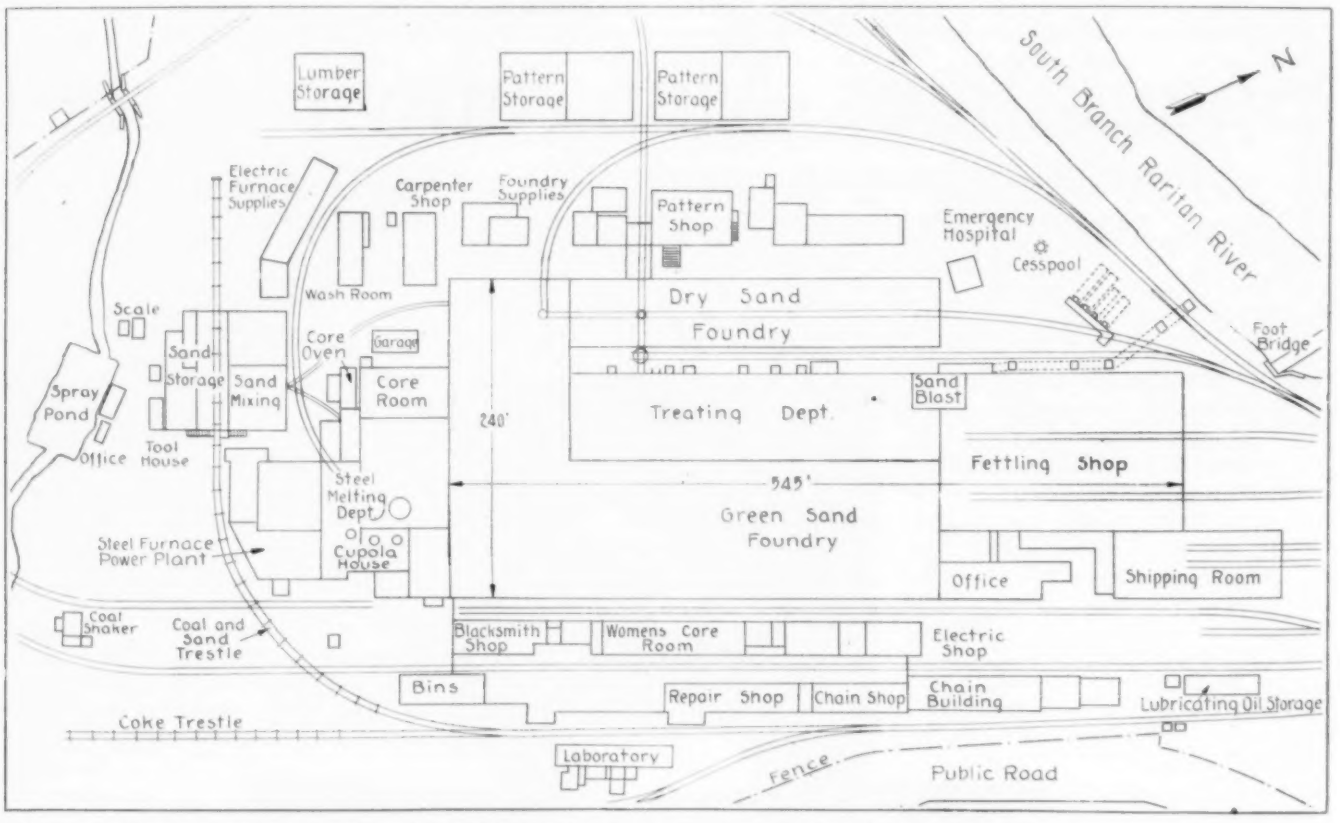


FIG. 2—PLAN OF THE STEEL FOUNDRY SHOWING A FEW OF THE AUXILIARY BUILDINGS—THE IRON FOUNDRY IS AT SOME DISTANCE TO THE LEFT AND THE OFFICES, A MACHINE SHOP, AND THE POWER PLANT ARE LOCATED AT THE RIGHT

High Bridge, between the public road and the south branch of the Raritan river. Northwest of the foundry, on the other side of the small river, are machine shops and the office building. The power house is located further up the river. Here steam is generated in coal-fired boilers to drive the electric generator which develops power for the electric furnace. Power also is developed by water turbines, water from the south branch of the Raritan river being used at two places for this purpose.

Down the river from the busy steel foundry, on the banks of a large pond, stands the old brick walled, wood trussed iron foundry. Its busy days are past, and now its single 39-inch cupola

melts only enough iron to make flasks, core arbors and machine parts required by the company. The old jib crane in the center of the foundry covers the entire molding floor in its circular swing, and makes no noise to mar the quiet of the rustic scene.

The only noise comes from the whirr and clatter of the great steel foundry across the river where castings are made: mostly of manganese steel, melted in converter and an electric furnace. Here the past is forgotten in the hustle and

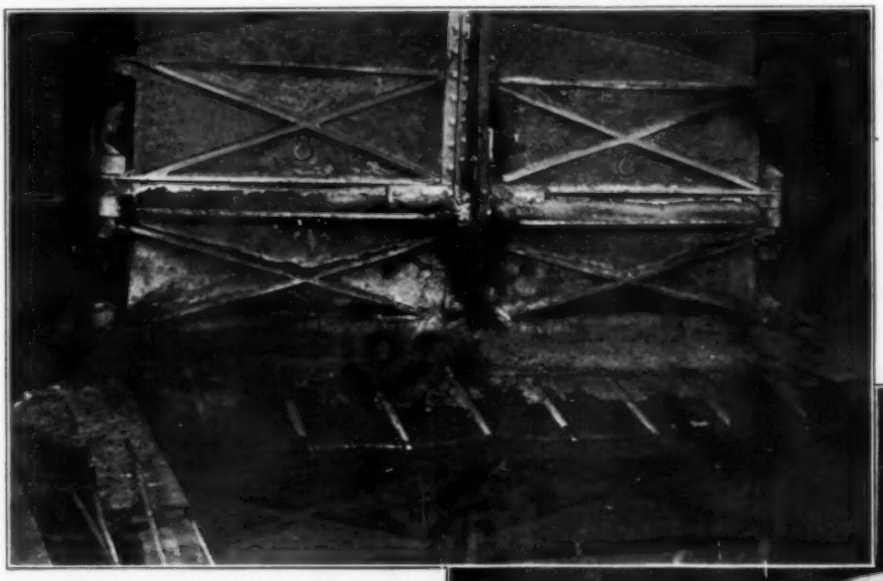


FIG. 3—THE QUENCHING TANK IS IMMEDIATELY IN FRONT OF THIS FURNACE

bustle of the present. Tracks from the New Jersey Central railroad enter the grounds from the north and branch off to both sides of the foundry and to the different buildings. The main portion, 545 feet long and 240 feet wide, is divided into the green sand shop at the east, the heat treating department in the center, and the dry sand foundry on the west, as indicated in Fig. 1. This latter is divided from the heat treating shop by a corridor through which is extended a track for the handling of waste sand. The girls' core room is in a separate building east of the main foundry, and the men's core room is in a building at the south end of the plant, near the dry sand department.

Weigh Stocks on Scale Cars

The melting units also are housed at the south end of the building. Pig iron and scrap are stocked in the yard along a railroad track being unloaded by a magnet handled by a locomotive crane. To bring them to the charging floor, a transfer car equipped with a scale carries a buggy to the different piles and the required amount of metal from each pile to make a cupola charge is weighed on the buggy as it stands near the pile. When the buggy is loaded with an entire cupola charge it is carried by the transfer car to tracks which lead to elevators. Coke is handled in box cars as indicated in Fig. 1, which shows two of the transfer cars, and rows of material ready to be taken to the charging floor. This illustration also indicates the thoughtful arrangement the company has made for the men working on the two floors. Two porches or balconies are provided where the men can get away from the heat of the cupolas.

The elevators which operate in pairs on the same hoisting engine, the one up and the other down, carry the charge to the second landing above the foundry floor, where the two 54-inch cupolas are charged. The metal then is tapped into a ladle on a platform scale on the first landing. The cupola tender watches the beam of the scale and as soon as he sees it kick he plugs the cupola. The metal is poured into one of the two 3-ton bottom blow converters below on the ground floor. The trough used for this purpose is indicated above the converter at the left in Fig. 4.

The charging floor for the two 30-inch cupolas which melt the ferromanganese used to raise the manganese content of the converter steel, is on the first level above the ground floor. The molten ferromanganese then can be tapped into a ladle on the ground floor and added to the metal from the converter. A similar system for securing an exact amount of metal in the ladle is used when tapping the ferromanganese as is described for the iron. It has been found that the proportions of metal can be determined closely in this way so that the resulting metal is within the limits of composition desired. Another small cupola, 18 inches inside diameter, is used to melt recarburizers for carbon steel heats, and is tapped onto the same scale as the ferromanganese.

Old and New Processes Used

The steel melting equipment is shown in Fig. 4, the two converters at the left and the electric furnace at the right. The latter is of the Heroult type, 3-ton capacity and basic lined. The electrode control is furnished by a regulator built by the Westinghouse Electric & Mfg Co., East Pittsburgh, Pa.

FIG. 4—STEEL IS MADE IN TWO BOTTOM BLOW CONVERTERS AND AN ELECTRIC FURNACE OF THE HEROULT TYPE

The original converter which blew the first heat of manganese steel made by the company still is in operation. These converters are lined with mica schist laid up with fireclay. The bottom section contains the tuyeres imbedded in the same mortar used to line the converters, and are detachable. This is indicated in Fig. 4 which shows the converter at the right turned with the mouth down and the bottom detached. The wind box with the connecting pipe may be noted in the bottom of the con-

verter at the left. Air pressure of 25 pounds per square inch is used for blowing the metal. A valve permits the air to be shifted from one converter to the other, and a fan is provided so that the one converter can be heated while the other is blowing in case it becomes necessary to change from one converter to the other during the day. Usually a converter is heated in the morning and blowing is started at about 9:30 o'clock being continued in the same converter the entire day. Bottoms always are kept in stock ready for use. They are dried in a coal-fired oven of the car type. The car is double decked so that four bottoms may be dried at a time.

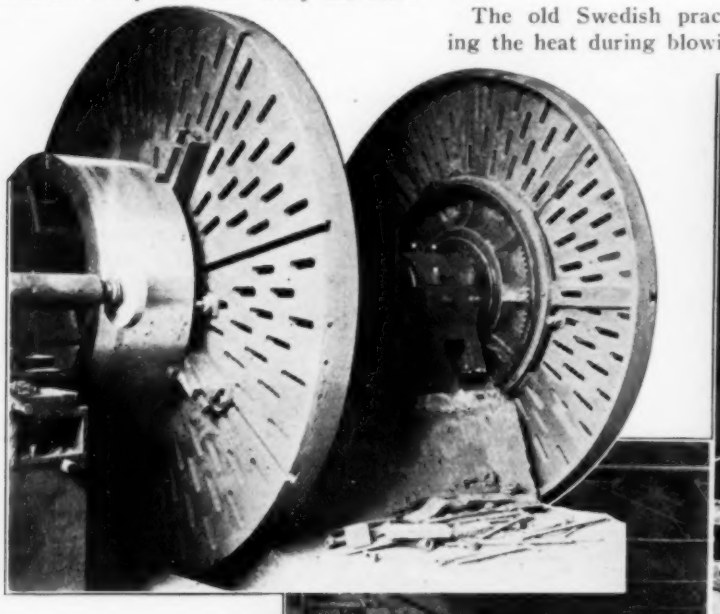
After the blow the steel is poured into a thoroughly dried ladle into which the required amount of molten ferromanganese has been transferred. The ladle then is carried to the green sand foundry by a crane, or to the dry sand shop on a transfer car, later to be handled by the crane. If a casting weighing more than 3 tons is to be poured, the steel is held until another, or even several heats are blown. Castings requiring up to 25,000 pounds of metal have been poured by the company. Before pouring, the slag is skimmed from the top of the metal and the ladle is weighed while empty.

Large castings are poured directly from the big ladle, but smaller castings are poured from bull ladles. All metal is poured over the lip, bottom pouring never being used. The bull ladles also are thoroughly dried. To accomplish this, wood fires are started in the ladles and the drying is completed by setting the ladles face down over a stove, or by the application of an oil burner. The two stoves consist of long troughs covered with 11 iron plates each of which is provided with a hole to allow the heat to reach the ladle placed on top. Heat is furnished by oil burners, one at each end.

The old Swedish practice of securing the heat during blowing from manganese as well as silicon is followed. As high as 30 per cent manganese steel scrap is included in the cupola charge and only a small percentage of manganese remains in the metal after it is blown. This may seem an expensive practice, but it has its compensations. By securing the heat from the oxidation of manganese instead of from burning silicon the blow can be finished in 8 minutes instead of requiring 14 minutes. Then the slag from both the converter and from the cupolas which melt the ferromanganese can be sold to blast furnaces on account of the high percentage of manganese contained. The slag from the converters contains 35 to 40 per cent manganese, while that from the ferromanganese cupola contains even a greater percentage. The melting loss is not excessive, being approximately 12 per cent total. The loss in the ferromanganese cupolas is kept low by using a low blast pressure and a low coke to ferromanganese ratio, and by using a flux of broken firebrick. The entire process of melting ferromanganese in the cupola is said to be novel and is patented. Blast pressure and volume gages on all cupolas help to keep down oxidation losses.

Not only is manganese steel scrap used in the cupola for metal for the converters, but almost the entire charge in the electric furnace is manganese steel scrap. The gates and sprue made in the foundry furnish remelt metal, but the amount is not enough to meet all the requirements and scrap is purchased. Much of this scrap is in large pieces and must be broken. As it is received it is too tough to break under the drop and cutting with the oxyacetylene torch is considered too expensive. Therefore, the company heats the large scrap and allows it to cool slowly which, contrary to the practice with other steels, makes the metal brittle. It can then be broken under a drop.

Facilities have been provided for this purpose at some distance from the foundry. A large piece of armor plate laid on the ground forms the anvil and a 3-ton low carbon steel ball is raised by an electric magnet carried by an overhead traveling crane allowed to fall on the piece to be broken. Both manganese steel and high carbon steel



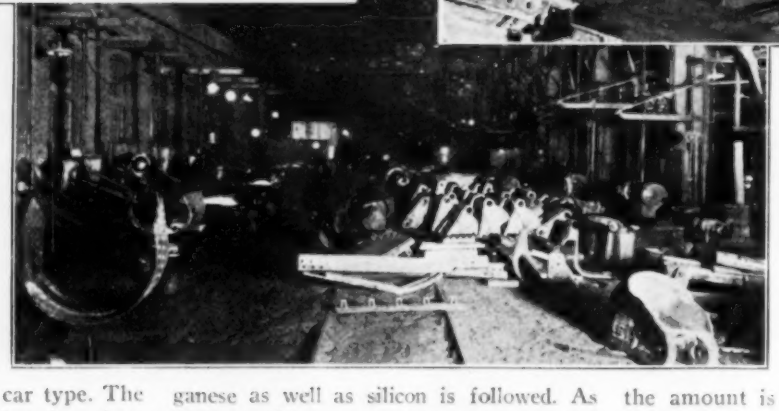


FIG. 5—ABOVE—GRINDING WHEELS REPLACE CUTTING TOOLS FOR FINISHING CASTINGS FIG. 6—AT RIGHT—SECTION OF THE FETTLING SHOP

FIG. 7—ABOVE—A LARGE HYDRAULIC PRESS STRAIGHTENS THE HEAVIER CASTINGS—TRACK CASTINGS ARE BENT LEVEL BEFORE BEING SHIPPED

balls were tried for this purpose but neither lasted as long as the low carbon ball which now has been in use for 3 years.

Having followed through the production of manganese steel in the ladle it will be well to consider the heat treating of the metal and the cleaning methods which are distinctive to this class of castings. The castings are taken from the molds at night and the gates and risers are removed before they are heat treated. As the castings come from the mold, the metal is brittle and the gates where possible are nicked in the mold where they join the casting so that they can be knocked off with a sledge without damage to the casting. Gates which cannot be broken off in this manner are cut off by the oxyacetylene flame, but this is seldom necessary. The castings also are rough cleaned before being heat treated, the cores being knocked out and the sand removed from the face of the castings. Fins are broken off as much as possible while the castings are in their rough state.

FIG. 8—TWO ELECTRIC OVENS AND ONE OIL-FIRED OVEN SERVE THE GIRLS' COREROOM

The metal being brittle and of high shrinkage, it is necessary to get the larger castings and those of complicated design into the heating furnaces before they become entirely cold, to prevent cracking. As might be supposed many such furnaces are required in this foundry. The heat treating department which is equipped with 14 furnaces of different design is served by two cranes which are used to put the castings into the furnaces and later to quench them. Only eight quenching tanks are required as in the majority of cases one tank at the front between two furnaces serves them both. Fig. 3 illustrates a case where a tank serves only one furnace. Here the castings which are put into the furnace on rollers are pulled from the furnace by the crane and lowered into the quenching tank. Other furnaces are of the car type and the entire car is pulled from the furnace and the crane chains are attached to skids which hold the castings, then the entire mass is lifted and lowered into the quenching tank.

Like the other operations in the process of making manganese steel castings, heat treating must be carefully regulated, and close temperature control is essential. The castings must be heated as close to 1060 degrees Cent. as possible before being quenched. To control the temperature of the furnace three six-point recording pyrometers have been installed. Each furnace is equipped with one or two thermocouples. These are of the rare metal type being formed of platinum and platinum-rhodium wires. To protect them from the flame which would soon destroy them they are covered with a porcelain tube and this in turn is protected by a tube of oxide resisting metal.

The recorders are of the potentiometer type made by the Leeds & Northrup Co., Philadelphia. Iron and constatin wires connect the cold ends of the thermocouples to the recorder, and as these wires generate the same electromotive force as the wires of the thermocouple they nullify the effect of any variations in temperature at the cold end of the thermocouple. A device in the recorder compensates for changes of temperature at the instrument. In addition to the recorders, indicating pyrometers, furnished by Charles Englehard, New York, are used as spare equipment in case of accident to the recorders.

The castings are finish-cleaned after they are quenched. This is made difficult by the nature of the metal and a great amount of grinding is required. The surface is cleaned in a sand-blast room and the castings are snagged on 14 double stand grinders, 12 swing grinders and 10 flexible shaft grinders. The crane runway from the green sand section and from the heat treating department extends into the cleaning room and five cranes are available for handling the castings. A view of this department is shown in Fig. 6. At the right may be seen some of the small jib cranes used to support the castings while they are ground on the stand grinders below. Four electric welders are operated.

FIG. 9—ONE SIDE OF THE GIRL'S COREROOM IS DEVOTED TO BENCH WORK AND THE OTHER SIDE IS EQUIPPED WITH ROLLOVER MACHINES

Two *machine* shops finish the castings. These are called machine shops because much of the same equipment used in a machine shop serves for finishing the castings but no cutting tools can be employed as the metal is extremely tough and offers too great resistance to the action of the tool. Therefore, grinding is resorted to and grinding wheels are used in every conceivable way. Fig. 5 shows a ring attached to a face of a double end lathe.

Many of the castings must be straight-

ened before being sent from the foundry. Smaller castings are straightened by a drop, but a large 600-ton hydraulic press is required to straighten track and other large castings. This press, which has a bed 13 feet 5 inches by 8 feet 7 inches between columns, is shown in Fig. 7. Track castings are bent level and shipped to William Wharton, Jr. & Co. where they are bent to fit the track layout. The jib crane which serves the press may be seen in the rear, Fig. 7. It travels up and down its supporting column on wheels. A smaller press is used for heavy drifting and a drill press has been rigged with an air hammer for lighter drifting.

The shipping room at the corner of the building extends slightly beyond the building where two tracks enter with a loading platform between. The floor of the room is concrete and rails are imbedded in the concrete in parallel rows in such sections where heavy castings rest. These serve to protect the concrete. Castings which are not shipped to the customer immediately upon being finished are stored in the yard, being handled by one of the two locomotive cranes which serve the yards, or by the battery truck. Flask storage is handled in the same manner.

Attention so far as been directed to the metallurgy and other features which are unusual in a steel foundry, but nothing has been mentioned about the metallurgical control or the molding and coremaking departments, both of which have interesting features. Before discussing the latter, mention should be made of the laboratory. The physical department is equipped with a 100,000 pound tensile testing machine and a bend test machine, both built by the Tinius Olsen Testing Machine Co. Philadelphia. A grinder is provided for sharpening drills and another for polishing microscopic samples. Hardness is determined by a brinell testing machine. Manganese is determined by the bismuthate method, the determination requiring only about 10 minutes. The sample is obtained by annealing the sample at a low temperature and then drilling with a high speed drill to a depth of ½ to ¾ inch.

The chemical laboratory is equipped to make the required analyses and a microscopic laboratory is furnished with a high-class microscope with photographic and polishing apparatus.

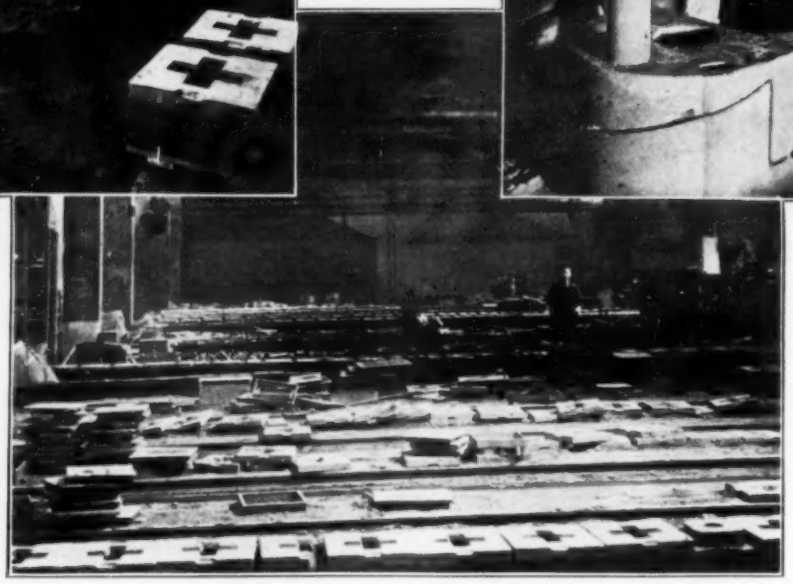
The first problem in molding and coremaking is the sand. The greater part of the sand used is secured from pits about 15 miles northeast of High Bridge, near Flanders, N. J. This is backed up with shore sand. It is milled in a building detached from the main foundry and carried to the foundry in steel buckets on battery trucks. Three mixers with automatic dumps built by the National Engineering Co., Chicago, and one of an older type prepare the core and facing sand. Oil, molasses and a dry compound are used for binders.

An interesting feature is the girls' coreroom, one end of which is shown in Fig. 9. Bench work is made on the one side, the girls placing the cores on drier plates supported on a row of racks behind them. Men carry the filled driers to the ovens. As may be seen from Fig. 9, the other side of the room is devoted to machine molding. Seven 16-inch rollover machines and two machines for making straight lengths of core are installed. These were supplied by the American Foundry Equipment Co., New York. The heavier cores are made on machines, but the girls are not allowed to lift weights over 15 pounds. However, as two girls work on a machine it seldom is necessary for them to have any lifting done for them. The cores are dried in two electrical and one oil-fired ovens. These ovens are shown in Fig. 8. As may be noted, they are of the drawer type, one drawer being pulled out at a time. A plate is provided at the back of each drawer to shut off the air from the oven when the drawer is out. These ovens were built by the Young Bros. Co., Detroit.

The heaviest cores are made in the men's coreroom. This is equipped with

FIG. 10—FACING SAND IS BROUGHT IN BARRELS TO THE MOLDERS MAKING SMALL WORK—NOTE THE BARREL HANGING ON AN I-BEAM TROLLEY

FIG. 11—AT RIGHT—MOLDS IN THE LIGHT WORK SHOP ARE MADE ENTIRELY OF CORES. FIG. 12, GREEN SAND MOLDING FLOOR



two 5-ton cranes and two rack type, two-track, double ended ovens. All core ovens are equipped with recording thermometers made by the Bristol Co., Waterbury, Conn.

As has been pointed out, the green sand shop extends from the melting department to the cleaning room. Both heavy and light work is made in this department. Fig. 14, which shows molds for gold dredging buckets, gives an indication of some of the heavy work which is handled. To serve these floors four cranes of 10 and 15 tons capacity are provided, and the three cranes which serve the cleaning department are sometimes called to serve in the green sand department when there is a rush of work. The molding is done either by hand ramming or by jar-ram machines. Two of the latter are provided with stripping plate equipment. Of the other two in this shop one is a large machine for ramming molds for switches, frogs and other long narrow castings. These four machines were made by the Herman Pneumatic Machine Co., Pittsburgh.

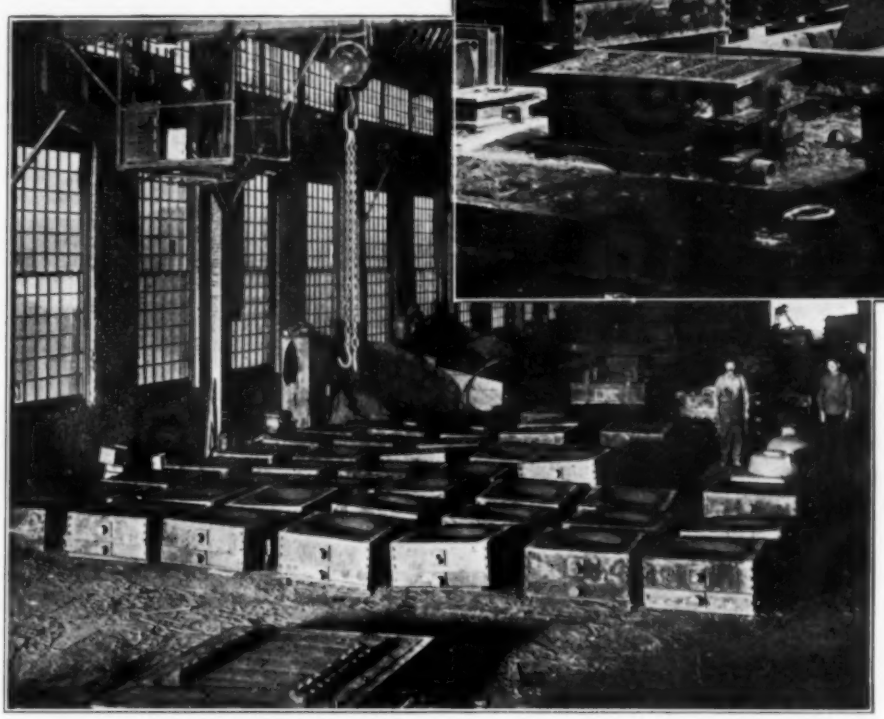


FIG. 13—CORNER OF THE DRY SAND SHOP SHOWING DAY'S WORK OF MOLDER AND HELPER MAKING SAFE MOLDS

Rigged for Light Work

One section of the green-sand department is rigged especially for light work. A portion of this section is shown in Fig. 12. The features are rows of long, narrow concrete piers, about 1½ feet high, for holding the molds, and above the rows I-beams on which the trolley for carrying the pouring ladle travels. The metal is brought to the floors by the crane in the main bay and is poured into bull ladles carried by the trolleys. In this way 3 tons of metal can be poured in 8 minutes, five or six crews working at once. Each pouring crew is composed of four men, two on the bull ladle, one on the chain hoist which carries the ladle, while the fourth skims. The molds are made on nine jar-ram squeeze machines manufactured by the Tabor Mfg. Co., Philadelphia. One of these machines is indicated in Fig. 10. When working on shallow patterns, like the one shown, only the squeezer is used, the mold not needing to be jolt rammed. The facing sand may be noted in the illustration in the barrel hanging by the chain hoist on the I-beam trolley.

A somewhat different form of molding carried out on the same floor is shown in Fig. 11. Here molds are being assembled for conveyer flights. These molds, as is clearly indicated, are made entirely of cores. The long round core above the mold at the left is put in the mold last and forms the bore of the flight. After a row of these have been set up they are weighted by a rail placed over them and clamped to the sides of the concrete pier by hooks. This is made possible as rails are bedded in the edges of the concrete to protect it from blows which might otherwise break the corners. Wood wedges underneath the upper rail serve to hold the molds firmly.

Dry Sand Shop

The dry sand shop is equipped with a jolt machine having a bed 96 x 148 inches and a lifting capacity of 65,000 pounds, and another machine of the same type with a lifting capacity of 25,000 pounds and a bed plate 96 x 96 inches, also a smaller one of 4000 pounds lifting capacity and a bed plate 30 x 45 inches. These machines were made by the Herman Pneumatic Machine Co. Four cranes serve the department, handling the flasks and carrying the molds to the five, double, car-type, drying ovens. Fig. 13 shows one corner of the dry-sand department. The molds for safe castings on the floor were put up in one day by a molder and his helper.

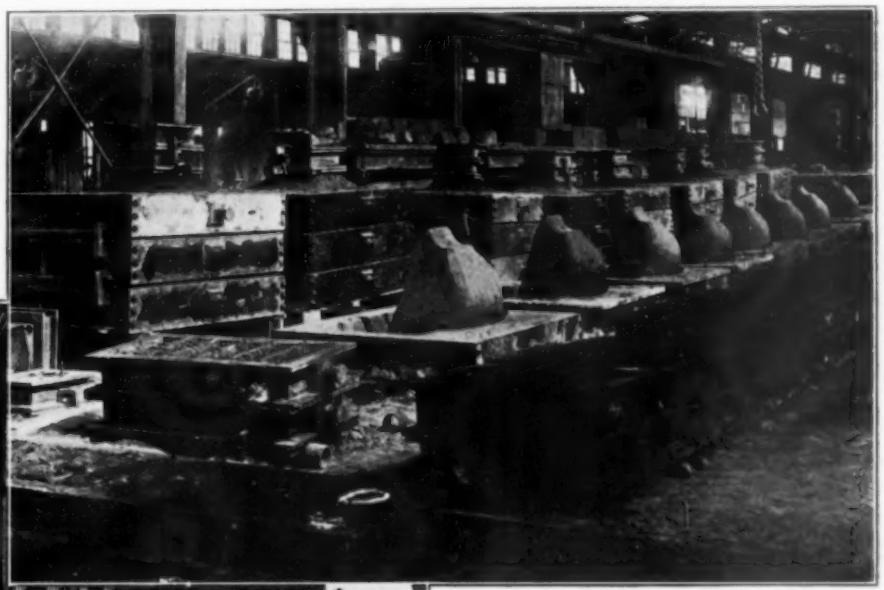


FIG. 14—MOLDS FOR GOLD DREDGE BUCKETS IN GREEN SAND SHOP

Among the numerous detached buildings are a pattern shop, three pattern storage buildings and a hydrogen-oxygen generating plant. The latter is equipped with 14 cells manufactured by the International Oxygen Co., Newark, N. J. The gas is pumped to two collector tanks. Another building houses a small carpenter shop and the men's showers and toilets.

The company makes and repairs both metal and wood patterns, and melting equipment is provided for the metal pattern department so that the rough patterns may be cast. The pattern shop and two of the pattern storage buildings are 2-story, while the third pattern storage building has three floors. The pattern storage buildings are brick and are divided into compartments by brick walls for fire protection.

Influence of Iron on Copper

From Personal Experience and Also from Investigation Carried on by Many Other Authorities It Is Apparent That the Iron Content in Any Brass Should Not Exceed 1 Per Cent

BY DR. F. JOHNSON

IRON is one of the most readily oxidizable impurities in blister copper. The analysis of impure black copper showed the presence of 3.037 per cent iron, which was brought down to 0.008 per cent in the refined ingot. Practically the whole of this elimination was effected at the close of the blowing period and before the true boiling period or sulphur elimination commenced. Lead and tin also are readily obtainable free from all but traces of iron, and electrolytic zinc contains a negligible amount. Distilled zinc, remelted zinc, nickel and manganese, frequently are contaminated with iron resulting from the close association of the ores of these metals with iron minerals.

Fortunately for the electrical industries in pre-electrolytic days, the tenacity with which iron clings to copper during the smelting stages is succeeded by a feebleness of union during the refining stages. Iron is detrimental to electrical conductivity since even 0.08 per cent lowers the electrical conductivity from 100 to 89 per cent.

Some difficulty has been experienced in obtaining copper perfectly diamagnetic, that is exhibiting no polarity under powerful magnetizing forces. Even so small an amount of iron as 0.004 per cent will cause copper to exhibit this magnetism although the magnetism is relatively small and vanishes on the removal of the magnetizing forces. For use in many galvanometers, wire should be obtained from copper deposited from a strongly acid mechanically agitated solution with low current density.

I have examined samples of copper submitted for utilization in magneto parts, containing up to 1.8 per cent of iron.

The only disadvantage conferred by the iron was a slight increase in the working hardness at high temperatures.

Alloying copper with iron is by no means easy, the rate of interdiffusion is so slow and the melting points of the two are so widely different. According to R. Ruer and F. Goerens in *Metal Industry*, Nov. 26, 1920, the limits of miscibility at the melting point are 23.8 and 85 per cent copper, within which range the freezing point falls from 1450 to 1375 degrees Cent. Separation into two layers only takes place when the alloy is heated 20 degrees Cent., above its melting point, otherwise the two metals remain emulsified. Ignorance of this fact led users of ferro-copper alloys to accept a 50-50 alloy as homogeneous. It is in reality an intimate mechanical mixture or emulsion of two solid solutions, one copper-rich and the other iron-rich. The melting point of the former is sufficiently near to that of pure copper to offer no difficulty in using it for the purpose of alloy making, but that of the iron-rich solution is about 300 degrees Cent. higher than the melting point of copper and, therefore, only a little better than pure iron itself. Smalley prepared an iron-copper alloy in two forms as a chill-cast ingot, which exhibited uniformity of composition, and as a large button slowly cooled from fusion.

In the former case, the emulsified condition was preserved by rapidity of solidification; in the latter case, separation into two layers took place.

Stead* showed that carbon is effective in promoting separation of the two solutions into two conjugate liquid layers, the heavier containing 10 per cent copper and 0.08 per cent carbon. The carbon would be associated with the free iron-rich crystallites which in that case would be of about eutectoid composition (0.8C). These 6-rayed crystallites, when free from carbon, increase in amount as the iron content increases.

The decolorizing power of iron is not so powerful as that of nickel. A copper-iron alloy prepared in my laboratory containing 10 per cent iron was little paler than pure copper.

An important application of this influence has been discovered in connection with the copper-aluminum-iron alloys and the so-called manganese bronzes. C. Vickers found that in the presence of aluminum, iron does not destroy the machining properties of copper alloys, while the addition of iron to copper-aluminum alloys—aluminum bronze—was beneficial in preventing excessive crystal-growth. He recommends the addition of iron up to 4 per cent and advocates the inclusion of iron in copper-aluminum gears, in which the teeth are formed by hot-rolling instead of cutting.

The importance of iron in reducing the

Table II

Maximum Allowable Percentage of Iron in 70-30 Brass

Maximum Allowable percentage	Reasons Ascribed	H. W. Brownsdon Ministry of Munitions Authority
0.15	Renders brass hard and tough and increases the mechanical difficulties.	Anon.
0.04	.....	(Metal Industry
0.10	.....	1916, 1X, p. 149)
0.50	(same for 70-29-1 condenser tubes and 63-37 cold-rolling brass)	C. R. Barton
0.05	.....	R. Mawson
0.045	.....	Doerinckel

Table I

Samples of Copper Submitted for Utilization in Magneto Parts

Mark on bar	Arsenic per cent	Iron per cent	Oxygen per cent	Maximum tensile stress in tons	Elongation per cent on 3"	Alternating endurance Arnold test	Angle of bend after gassing
E	0.34	nil	0.066	15.70	41	190	0
U1	0.37	0.05	nil	16.15	46	211	180
U2	0.69	0.43	nil	17.05	48	244	180

Abstracted from a paper read at the Birmingham local section of the British Institute of Metals. The author, Dr. F. Johnson, is head of the metallurgical department of the Birmingham municipal technical school, Birmingham, England.

1*Journal Iron and Steel institute, 1901, 11, 104.

grain-size cannot be too highly emphasized. One of the greatest sources of weakness in propeller blades and other large castings is a coarsely-crystalline structure. H. B. Weeks in discussing N. J. Maclean's * * paper points out that a tensile strength of only 12 tons per square inch could be obtained on a test-bar cut from such a casting, whereas a strength of 30 tons per square inch could be obtained from a small test-bar cast on the blade and having a much finer grain-size. High-strength brasses now are made giving the following figures: Yield, 20 tons per square inch (44,800 pounds); Max, stress, 40 tons per square inch (89,600 pounds); Elongation, 20 per cent. The inference is that the addition of iron to the alloy has been responsible for this wonderful improvement.

O. Silberrad * * 1 who has made an extensive study of the erosion of bronze propellers, points out that the greatest resistance to frictional rub of the water and to the impingement of vacuum bubbles (which subsequently collapse) is offered by alloys consisting wholly or mainly of the beta phase. However, as pure copper-zinc alloys of this class are insufficiently strong, small quantities of iron, aluminum and manganese must be introduced.

Taking 70-30 cartridge-brass as the typical alloy of the alpha brasses and one of the most important industrially, it is of interest to note what the general attitude of metallurgists is toward iron.

Little difficulty is experienced in obtaining good commercial brands of copper containing only traces of iron, but commercial brands of zinc, with the exception of electrolytic zinc, are not so free from iron. Taking haphazard the results of analyses of many commercial brands of spelter over a period of five years in a large brass and copper works, I found the lowest iron content to be 0.04 per cent and the highest 0.59 per cent. The average was 0.110 per cent. In the distillation of zinc ores, iron is a source of loss, in that it forms Fe_2ZnO_4 (Zincate of iron) which is less readily reducible than ZnO; but there seems to be no evidence that the product of reduction of this compound by solid carbon would be a volatile compound of iron and zinc.

Some of the opinions of various authorities on the maximum allowable percentage of iron in 70-30 brass are shown in table II.

In addition to the zinc, other sources of contamination in brass making, include (a) the iron or steel rod used for stirring the molten mixture, (b) ferruginous scrap and (c) swarf containing iron or steel chips. That iron tends to accumulate in brass with re-melting is well known and Professor Turner gives the following composition of a so-called *poisoned* brass which must have resulted from many re-meltings and blendings:

Analysis of Poisoned Brass

Cu.	72.53 per cent
Zn.	11.65 per cent
Pb.	7.11 per cent
Sn.	5.52 per cent
Fe.	2.00 per cent
Al.	0.75 per cent
As.	0.09 per cent
Mn.	0.06 per cent
P	nil.
	99.71 per cent

One of the reasons urged against the commercial production of brass die-castings is that molten brass readily and speedily attacks and spoils the expensive steel dies, becoming itself contaminated in the act.

In view of the foregoing it is highly creditable on the parts of Birmingham manufacturers of cartridge brass and condenser-tubes that the iron content is kept so low. I have made many analyses of condenser-tubes and usually found the iron content in the neighborhood of 0.10 per cent, never above 0.15 per cent. Bengough relates that he has not infrequently found 0.25 to 0.35 per cent iron in ordinary condenser tubes and that occasionally 0.5 per cent is reported. Analyses made in my laboratory and shown in table III indicate that other alpha-brass materials may contain excessive quantities of iron.

Brass *A* failed owing to the inability of the metal to flow sufficiently easily to fill the die, while brass *B* was quite satisfactory. Brass *A* had a finer grain, a greater hardness, yield point, tensile strength and a lower percentage elongation than brass *B*. The Erichsen test on these brass sheets (0.038 and 0.04 inches thick respectively) gave exactly similar Erichsen numbers, but brass *A* showed a well developed crack, whereas *B* showed only an incipient crack. Brass *C* was in the form of a casting and was probably better for the presence of iron than without. Brass *D* was made from pig-brass and was intractable in the rolling mill.

There can be little doubt that a general crusade in favor of iron elimination from all brass of cold-rolling or cold-drawing quality would be beneficial. Moreover, brass rich in iron is more liable to corrosion than brass low in iron. It will be difficult to completely exclude iron and cases must arise in which, inadvertently, an undesirable amount has found its way into a batch of material. Smalley has shown that its hardening influence may

Table III

Alpha Brass May Contain Excessive Quantities of Iron

	A. Bad brass cup made in made in draw-press	B. Good brass cup	C. Brass cog-wheel	73.71
				24.88
Cu.	69.73	67.55	67.61	1.15
Zn.	29.93	32.25	29.72	0.20
Fe.	0.83	0.136	0.50	0.06
Pb.	0.6	0.06	2.0	D.
Sn.	....	....	0.13	Brass strip

Table IV

Typical Analysis of Long Established Bearing Metals

	Sterro Metal	Aich Metal	Delta Metal
Cu.	60	58-60	55-56
Zn.	38-38.5	36-41	41
Fe.	2- 1.5	0.7-1.7	0.8-1.6
Sn.	nil	0-1.0	1.0 (Mn. etc.)
Pb	....	....	0.7-1.8

Table V

Maximum Improvement with 1 Per Cent Iron

No. of bar	Composition per cent Cu.	per cent Fe.	Pouring temp. C.	Yld. Pt. tons per sq. in.	Max. Str. tons per sq. in.	Elongation per cent	Brinell h'dness	Condition
5 A.R.	554	nil	900	8.53	29.3	22	95	As cast
			900	7.67	29.4	26	86	annealed
			900	36.3	41.1	4.25	173	Cold rolled
6 A.	56.0	1.14	970	11.1	32.6	36	93	As cast
			970	10.15	32.8	37	84.5	Annealed
			970	....	43.8	16	158	Cold rolled

**Journal Institute of Metals XXIII, No. 1, 1920, p. 193.

***Journal Institute of Metals XXI, No. 1, 1919, p. 176.

be greatly mitigated by correct annealing. By raising the ordinary temperature of annealing, a satisfactory degree of softness may be obtained. However, few things are so inimical to the smooth-running of works' processes than the frequent alterations of working conditions to offset haphazard variations in composition.

Occasionally it is quite legitimate to salvage a batch of material, which, in spite of all the watchfulness expended upon it, has, in some way or other, picked up an over dose of iron.

R. A. Wood in a paper on brass rolling-mill alloys * * * * points out that where dense grain associated with great strength are required, iron may be added to the mixture. The addition of iron increases the amount of piping and renders casting difficult. It also tends to segregate in the form of small, hard nodules. It is best added as a 50-50 ferro-copper, while manganese materially assists in the distribution of iron. Alloys containing iron are springy and will not take the same heavy reductions as zinc-copper alloys.

O. Smalley not only made ordinary physical and mechanical tests on the specially prepared alloys, but the drawing and cupping properties were determined by the actual manufacture of ferrules and fuse primers, in the production of which each of the properties previously separately examined, plays an essential part. He found that iron 1 per cent raises the yield point of 70-30 brass in the cast condition from 6.5 to 10.7 tons per square inch, the tensile strength from 16.7 to 24.5 tons per square inch and the brinell hardness from 55 to 76 (1000 kilograms load) without materially affecting the ductility as measured by static and dynamic tests. Improvement is maintained when the brasses are rolled and annealed, the temperature of annealing being that necessary to just restore the brinell hardness of the original casting.

From these tests it is apparent that iron up to 1.00 per cent is not detrimental to the cold-working qualities of 70-30 brass if correctly alloyed and if the intervening anneals are correctly performed. In the absence of either of these conditions its effect will be something similar to that of a mechanical intrusion and result in the presence of attenuated cracks running in the direction of application of mechanical work.

I cannot agree with the statement: Iron up to 1.0 per cent is not detrimental to the cold-working properties; for however correct the alloying and the performance of the intervening anneals the iron brass always will have a higher yield point than ordinary brass and always will thus consume more power to effect a given reduction, while the intervening anneals also will be more costly. Of what avail is it to have the considerable range of physical properties (yield point 10.7-18.5 tons per square inch; maximum stress 24.5-41 tons per square inch; in elongation 14-54 per cent; brinell hardness 72-185, etc.) when the manufacturing costs are mounting up?

Such a range of properties might be obtained from an alloy of higher zinc content in which case the costs of material and of manufacture would be lower. For the manufacture of springs, doubtless, iron is beneficial, if alpha brasses must be used for such articles.

Smalley places the safe working limit for articles which are to be spun, cupped or drawn at 0.35 per cent iron which he regards as the limit of solubility of iron in brass.

One inevitable conclusion to be drawn from a consideration of the foregoing facts is, that whether iron be added to brass intentionally or not, the proportions in which it is allowed to exist must be under control, as must the proportions of other impurities. However beneficial an impurity such as iron may appear to be by itself when added to a brass made from pure metals, a different story may have to be told when other impurities are present.

It is interesting at this stage to remind ourselves that the value of iron as an additional ingredient to duplex brasses which may be worked hot *was* recognized by the early pioneers of these special alloys. Typical analyses are given in table IV.

Opinions conflict regarding the manner in which iron is introduced, although Alexander Dick took out a patent for introducing iron as a ferro-zinc alloy.

Brannt states that the difficulty of causing iron to alloy uniformly with brass is overcome by using a specially prepared ferro-zinc alloy, containing 8.5 per cent iron. This is the method which I prefer, although objections have been raised on the grounds of high zinc losses caused by the length of time required for solid iron to dissolve in molten zinc, even at 800 degrees Cent. The ferro-zinc prepared for my own experiments was made by immersing commercially pure strip iron (previously cleaned) in molten zinc and maintaining it at a temperature of 800 degrees Cent. for some hours. The lid was luted on almost completely to prevent access of air. Alloys thus made are fine-grained and silvery-gray in color and melt readily at a temperature lower than that of commercial brass.

According to an investigation of zinc-iron alloys carried on by V. Raydt and G. Tammann iron enters into solid solution *M* in zinc up to about 0.7 atomic per

Table VI

Differences Between 60-40 Brass with and without Iron

Composition	Physical condition	Yield point, tons per square inch	Max. stress, tons per square inch	Elongation, per cent on 2 inches	Reduction of area per cent	Alternating impact No.	Brinell hardness No.	Sclerescope hardness No.
Cu. 58.96 Zn. 41.04	As cast	8.80	24.90	45.00	49.70	79	90	14
	As forged.....	9.00	26.00	47.50	62.00	87	90	14
Cu. 59.37 Zn. 39.68 Fe. 0.95	As cast	9.40	26.80	44.00	44.60	95	90	13
	As forged.....	13.90	28.80	44.00	63.70	81	107	14
Cu. 59.04 Zn. 38.95 Fe. 1.56 Pb. 0.45	As cast	11.00	26.80	33.00	30.60	31	85	13
	As forged.....	13.60	27.60	43.00	59.30	49	98	15
Cu. 59.12 Zn. 38.36 Fe. 2.52	As cast	10.00	26.50	46.00	49.70	71	92	14
	As forged.....	15.80	28.30	39.00	54.60	79	110	16

Table VII

Analysis of Damaged Periscope from Damaged German Submarine

	Per cent	Per cent
Cu.	53.0	60.0
Zn.	34.0	34.0
Ni.	9.0	3.0
Fe.	1.5	2.0
Mn.	1.5	0.5
Al.	0.35	...
Pb.	...	0.25
Phosphor tin	...	0.25

4 American Institute of Metals, 1917, XI, p. 181.

cent. With more iron a second phase appears consisting of a solid solution *N* of iron in zinc. This phase increases in amount as iron increases, the *M* phase disappearing at a concentration of about 8 atomic per cent iron. The alloys then consist entirely of the *N* phase up to 10.9 atomic per cent at which concentration the alloy consists of Fe Zn. Further additions of iron result in the formation of $FeZn_3$ which exists side by side with Fe Zn_7.

The iron-zinc alloys are brittle, differing thereby from tough ferro-copper alloys and present no difficulty in breaking up for weighing out purposes. Smalley raises the objection that ferro-zinc would not furnish sufficient iron for the manufacture of alloys low in zinc and high in iron and that the process of making ferro-zinc is costly. As 1 per cent of iron is the maximum proportion desirable in 70-30 brass, it will be seen that only 1/8 of the zinc added need be in the form of ferro-zinc (8 per cent iron).

In view of the impression which has existed for many years concerning the beneficial influence of iron in certain alloys it is somewhat disappointing to find on investigation, that the improvement in mechanical properties appears to be not so great after all. The experimental bars made in my laboratory were small and open to criticism on that account, but Smalley's billets were on a manufacturing scale and are free from such criticism. They fail to reveal either in the cast or forged condition a phenomenal improvement as the result of iron additions. Table V shows the percentage differences between test values of 60-40 brass containing iron and those of standard iron-free brasses of various investigators. The results obtained by Smalley are the most worthy of examination, as his working conditions were affected by fewest variables. The compositions of Millington's bars are uncertain while inequality in pouring temperatures prevents my own bars from being strictly comparable. The results of the tests on the annealed bars may be regarded as fairly comparable and these reveal no improvement as the result of adding 0.72 per cent iron. Probably the benefits derived from the addition of iron become more marked as the size of the casting increases. The results obtained by Smalley indicate that the improvement in mechanical properties is less pronounced than in the case of alpha brass.

In the case of brasses consisting almost entirely of the beta phase, iron effects a marked improvement, causing an increase in the relative proportion of the alpha phase, reducing the grain-size and improving the mechanical and cold-working properties in many ways. These features are shown in Table VI. The maximum improvement being obtained as in Smalley's work, with 1 per cent of iron. The chief figure relating to the standard brass and the 1 per cent iron brass are extracted.

Table VIII

H. L. Heathcote's Stampings

	Stamping 1	Stamping 2	Rod 3	Stamping 4
Cu. per cent	59.44	59.29	59.20	57.80
Zn. per cent	37.34	38.07	38.51	39.6
Sn. and Sb. per cent	0.69	0.49	0.89	0.99
Pb. per cent	2.04	1.61	0.40	nil
Al. per cent	0.31	0.24	nil	0.08
Mn. per cent	0.06	0.038	nil	0.25
Fe. per cent	0.47	0.34	1.09	1.01
Brinell hardness No.	92	90	..	105
Yield point, tons per square inch	10.07	10.52	24.19	10.15
Tons Str.	25.65	25.20	34.3	22.92
Elongation per cent	26.4	23.4	28.8	37.8
Machinists report	Very good	Good	Hard	Very hard

Of the two bars shown in table VI the standard brass consisted entirely of the beta phase. The 1 per cent iron brass contained a considerable amount of alpha. That the latter is considerably more amendable to cold rolling is shown by the greater amount of residual elongation and the lower brinell number in the specimen as rolled.

Effect of Iron

From the foregoing it is apparent that the all-beta alloys (5 AR) are less amenable to plastic deformation than the alloys of the same copper content containing iron (6A). Iron has just the opposite effect to that of aluminum, and for practical purposes we may look upon iron as an element which shifts the alpha plus beta phase-field boundary to the right and doubtless the alpha field similarly.

Results of further tests by Smalley indicate that iron is detrimental to the ductility in the cast state but beneficial in the forged state. This is explained by Smalley as follows:

(a) Iron although reducing the grain-size gives to the crystals a more regular geometrical shape and they are more nearly idiomorphic in character than the crystals of a pure brass. The inference is that cleavage paths are more readily produced in the former and the process of slip hampered by the greater prevalence of intercrystalline boundaries.

With regard to (b) Smalley's photomicrographs clearly show, not only the finer grain-texture of the iron-brasses, but also the more jagged crystalline boundaries and the mutual interpenetration of the grains. There is an analogy here to the superiority of rolled zinc over that of cast or annealed zinc. Once the elongated structure has been destroyed, brittleness replaces ductility and it seems highly probable that the superior ductility of these ferruginous beta brasses in the forged state would disappear if the elongated structure were replaced, on annealing, by an equi-axed structure. The valuable function of iron here appears to be in retarding the recrystallization of the plastically-deformed beta grains.

Little can be said about the influence of iron in alpha plus beta nickel-brass, but the analysis of a damaged periscope from a German submarine is given in table VII together with that of an alloy which N. J. Maclean proposes as suitable for the manufacture of precision instruments for naval use.

Maclean states that with his proposed alloy, he could rely upon getting in sand-castings the following tensile test results: Elastic limit, 10 tons per square inch; maximum stress, 20 tons per square inch; elongation, 15 per cent in 2 inches. The iron is introduced in the form of a special hardener of the composition, copper 75, nickel 15, iron 10, using phosphor-tin as a deoxidizer.

A bewildering variety of compositions fall into the category of manganese-bronzes. Iron invariably is found in these alloys its special functions being, (a) reduction of grain-size; (b) conferment of strength as the result of (a) and as the result of entering into solid solution; (c) conferment of toughness by reason of (a) and by the precipitation of more of the tough alpha phase than a pure brass of similar copper content would contain. This property is represented by the coefficient of equivalence assigned to iron by Guillet, viz.: 0.9. Iron converts an alloy into one having the properties and structure of an alloy of lower zinc content. This also is true of manganese but alumi-

Table IX

Analysis of Unsatisfactory Condenser Tubes

	Cu. per cent	Zn. per cent	Pb. per cent	Fe. per cent
Patent brass tubes	69.94	29.23	0.32	0.39
do	69.82	29.20	0.36	0.50

num acts more in the opposite direction. This partly accounts for the association of these three metals in complex brasses, the two former acting as a brake on the embrittling influence of the latter.

There can be no doubt that iron has no beneficial influence upon the machining properties of brass. The mere fact that it toughens brass adds to the machinist's difficulties and if imperfectly alloyed, its presence in the form of hard nodules will blunt the edge of the cutting tool rapidly.

It will be seen from the figures in table VIII for the high-iron brasses 3 and 4 that high-iron is accompanied by high-tin and low-lead content and thus the iron content is not a true criterion of the behavior in machining.

In a paper read before the Sydney division Institute of Engineers, Australia, March 1921, E. Bate relates that, among other condenser tubes these shown in table IX were put to a practical test in the Ultimo White Bay power house, Sydney, N. S. W.

These tubes proved to be liable to dezincification (apparent) being from 100 to 200 per cent worse than tubes of admiralty brass.

Bengough regards iron as the most harmful of the common impurities and states that it greatly enhances the rapidity of the white salt attack in sea waters. In hard fresh water the presence of iron is much less harmful than in the case of seawater. As a corrosion product, iron oxides and hydroxides in certain physical states are slightly soluble in sea-water, yielding what is practically a solution of ferric chloride—a very corrosive substance. If such substances stick to a new or nearly new tube, i. e. one which has not become coated with carbonate scale, a local attack on the tube may take place. In condensers the ordinary flocculent hydroxide is readily swept away in the water stream.

H. Rix and H. Whitaker confirm the conclusion of C. Vickers that iron reduces the grain-size of aluminum-bronze; they include also chill-castings. They also confirm Corse and Comstock in their conclusion that iron increases yield point and tensile strength at the expense of ductility and prefer iron to manganese in sand-cast bars because it gives better all-round properties. The range of alloys recommended for commercial chill-castings is 7-10 per cent aluminum 1-4 per cent iron. A. D. Wilson in pages 800-804 THE FOUNDRY, 1921, confirms the conclusion of previous workers regarding the beneficial action of iron up to 4 per cent in aluminum-bronzes containing up to 12 per cent aluminum. Beyond 4 per cent iron the improvement ceases and casting difficulties are greatly increased. The surfaces of stressed test bars become smoother as iron increases and grain size diminishes. The iron is held in solid solution up to 1 per cent but beyond that an iron-rich constituent appears in the form of small dots which increase in number and size with increase of iron until well-defined dendritic crystallites are seen.

Wilson follows other investigators in attributing the fineness of grain to the iron-rich particles acting as nuclei. The alteration of shape of the contiguous alpha and beta crystals to which attention has been drawn in connection with my examination of iron-brasses is shown to be effected by iron in copper-aluminum alloys.

Sir J. Dewrance, A. Philip and J. S. Primrose suggest that a hard iron-tin compound is formed by iron in gun-metal. Primrose suggests that this compound makes its appearance in the delta constituent with as little as 0.11 to 0.15 per cent. Its effect, however, is not determinable until the iron has reached 0.3 per cent while the effects of 0.6 to 1.0 per cent are harmful. H. S. Gulick states that iron raises the tensile strength and lowers the elongation, and J. Arnot states that iron is seldom present in more than traces, but when these are exceeded it is liable to cause hard spots.

Experiments of my own on the influence of iron in small chilled castings show that iron in the proportion 0.35 per cent has a beneficial influence on the mechanical properties. The same remark applies to the influence of 1.0 per cent iron accompanied by 0.16 per cent aluminum as shown in table X. The effect of iron alone is to make the alloy sluggish in pouring, but the presence of a small quantity of aluminum restores the fluidity.

I do not suggest that the results shown in Table X are what might be expected in large castings, but an investigation of the influence of iron in large castings, when properly alloyed is desirable.

Finally it may be pointed out that the problem accompanying the introduction of iron into nonferrous alloys is an ancient one as may be seen from the analyses of ancient bronzes shown in table XI.

In a summary of influence of iron on copper it may be stated that iron up to 1 or 2 per cent deoxidizes, toughens and strengthens copper, even in the presence of arsenic. It has a powerfully inimical influence on electrical conductivity and a very small quantity makes the metal paramagnetic and unsuitable for using in galvanometers.

In connection with alpha brass there appears to be an overwhelming weight of opinion in favor of keeping the iron content not higher than 1.00 per cent for the reasons that it increases casting difficulties, power required for mechanical operations, annealing costs and corrodibility.

For special purposes articles required to be stiff and springy, the addition of iron is advantageous, but it need not exceed 1.0 per cent.

Advantage might be taken of the influence of iron in raising the annealing temperature of cold worked alpha brass, to increase the convenience of the low temperature annealing processes for the removal of internal stresses of cold-worked material. A slightly higher temperature

Table X

Influence of Iron on Small Gun Metal Chill Castings

Mark	Cu. per cent	Sn. per cent	Fe. per cent	Yield pt. tons sq. in.	Max. stress tons sq. in.	Elong. per cent	Brinell h'dness (500 kegs)	Remarks
S	88.0	9.85	nil	11.7	23.15	19	80	As cast
H	86.7	10.4	0.35	16.8	27.1	21	96	do (ferro used) cpr. sluggish
HI	88.7	10.08	0.99) 0.16AE)	16.3	27.8	18.1	100	As cast fluid
HI	88.7	10.08	0.99) 0.16AE)	14.85	29.3	55	..	

Table XI

Appreciable Quantity of Iron in Ancient Bronzes

Per cent	Ancient Eastern Bronzes (chikashige) Chinese Arrowhead	Sword	Knife Money	German Bas-Relief Early 17th century (Gowland)
Cu.	74.47	69.31	38.38	65.34
Sn.	10.82	12.55	1.66	5.04
Sb.	8.00	2.30	....	....
Ni.	3.68	3.52	1.03	0.10
As.	trace	3.01	0.60	....
Pb.	nil	7.92	55.41	2.09
Fe.	3.03	1.37	2.66	1.79
Zn.	....	....	....	25.64

of annealing would mean a shortening of the annealing period—an advantage in works' practice.

Iron appears to serve a useful purpose in alpha and beta brasses particularly in reducing the grain size and improving the strength and toughness. The indications appear to show that the beneficial action is greater in the case of brasses in which the beta phase is in excess.

The grain size in beta brass is reduced, but no improvement in mechanical properties appears to accrue in the case of castings. An improvement, especially in ductility, has been found to occur in the case of hot-forged and rolled bars. This may be due to retardation of re-crystallization during the hot-working process. For nickel-brass the addition of iron has been specially recommended for cutlery stock and extra hard springs. In *copper-aluminum* or aluminum-bronze, iron has been found to be very beneficial in reducing grain-size, retarding crystal growth, and facilitating the production of die-castings. Iron does not appear to be detrimental to admiralty gun metal if correctly alloyed. The mechanical properties are enhanced under such conditions.

Dr. H. W. Brownsdon, chief chemist to Kynochs Limited, who opened discussion, said that Dr. Johnson had shown clearly that if ease of working was required the only safe way to deal with iron was to get rid of it so far as possible because otherwise one became so involved in questions of grain size and different temperatures of annealing that it was well nigh impossible to control the processes necessary to give a uniform final product. With regard to the magnetic effect resulting from the presence of small quantities of iron in brass, he had the opportunity when his colleague, Mr. Malam, was working on this subject of going closely into the question. Mr. Malam worked out a most ingenious quantitative method by means of a delicate magnetometer for determining the iron in brasses. When two equal masses of brass were placed at equal distances from the end of the delicately suspended needle any iron present in the brass caused deflections of the needle proportional to the iron content.

The presence of phosphorus in brass appeared to increase the hardening influence of iron. With about 0.04 per cent phosphorus the hardening effect of iron increased up to about 0.07 per cent of iron and then decreased again. Small quantities of phosphorus were not unknown in cartridge brasses and when present the effect of iron became of increased importance. He was rather inclined to think that the solubility of iron in brass was not so high as had been stated, and one might surmise that if the iron were in solid solution there would be no magnetic effect. No magnetic effect was obtained from spelter containing small quantities of iron. That made one think that the magnetometer might find an application in determining to what extent iron in a metal or alloy was free or in solid solution.

Mr. T. Henry Turner, M.Sc., a son of Professor T. Turner and recently appointed assistant lecturer in metallurgy at Birmingham university, referring to the influence of iron in condenser tubes, said that he had examined American, German and Dutch tubes and had found in them a much greater iron content than in English tubes. It was quite usual to find 0.35 per cent and even with the best he never got less than 0.10 per cent. The highest iron content in the American tubes was 0.75 per cent.

In reply to a question as to the influence of iron in causing fire-cracking in nickel-silver, W. R. Barclay, O. B. E. Henry Wiggin & Co., Ltd., said that iron was about the third element they looked for when fire-cracking occurred. The first thing they looked for always was carbon, because the presence of carbon in graphitic form is the most frequent cause. The second element they looked for was lead and the third was iron. They had never been able to get any clear light on the difficult question of how iron behaved. That it did cause cracking in nickel was certain. It hardens it in the rolling but it certainly has a much less pronounced influence than lead on fire-cracking and other peculiar features.

How and Why in Brass Founding

By Charles Vickers

Coat Aluminum Patterns To Prevent Rust

Where we store aluminum patterns over a long period of time we find that corrosion sets in. They become covered with a white substance and when this is removed the surface of the pattern is pitted. How can we prevent corrosion?

The white substance to which you refer is hydrated aluminum oxide, in plain English, aluminum rust. It is due to the cause responsible for any metal rusting, exposure to damp atmosphere. Iron or steel objects placed in storage are prevented from rusting by covering them with a protective coating of oil, grease or special preparations designed to exclude the air. The same method, with modifications may be adopted for aluminum patterns.

In one method extensively practiced, the pattern first is warmed and then coated with a thickness of beeswax applied uniformly with a hard brush slightly warmed. If necessary, bayberry wax may be substituted for beeswax. A prominent pattern supply house advertising in THE FOUNDRY handles a special wax designed for the same purpose and handled in the same manner as either beeswax or bayberry wax. The wax coating does not harm the patterns. Before the pattern again is placed in the sand, it is warmed slightly and the wax may be brushed away altogether, or, the usual small finishing coat allowed to remain.

Aluminum Bronze Presents Porosity Trouble

We have some trouble making aluminum bronze bushings 2 to 4 inches outside diameter, 1 to 2 inches inside diameter and from 6 to 12 inches long. We pour them on end. The metal is melted in a gas fired furnace and kept well covered with charcoal. We have no trouble making smaller bushings from the same alloy, copper 88 per cent, aluminum 11.50 per cent, silicon 0.30 per cent, iron 0.20 per cent.

Nearly all defective bronze castings may be traced to porosity, dross and shrinkage and a fair sized book could be written on the subject of how to prevent trouble while handling this metal. Silicon does not cause porosity, but neither does it improve tht alloy and we suggest that you omit it from future mixtures. One pound of 30 per cent manganese copper added to the molten copper before the aluminum will assist materially in producing sound castings. Iron always is beneficial and we know no reason why the amount indicated should not be increased. Use nothing but a clean crucible, melt the copper under charcoal and do not spread any flux on this alloy. When the copper is sufficiently hot, add either the iron or the manganese copper and afterward the aluminum. Allow the alloy to cool to a bright gold color before it is

poured. Gate the mold at the bottom and provide liberal risers to serve as feeding heads.

Stiff Manganese Bronze Rail Stanchions

We are making rail stanchions from manganese bronze and find that they bend too easily when the weight of a person's body is thrown against them. We want to substitute a more suitable composition, one that will not bend easily or break and one that is not too expensive.

Manganese bronze may be prepared in varying degrees of strength and hardness. For example one variety may exhibit a tensile strength between 60,000 and 65,000 pounds and an elongation of 50 per cent. A stiffer alloy may show a tensile strength between 80,000 and 85,000 pounds and an elongation of only 18 to 25 per cent. It is apparent that the first alloy will bend much more readily than the second. We suggest that you do a little experimental work to determine the alloy most suitable for the particular castings you have in hand.

An aluminum bronze that will suit your purpose admirably may be prepared according to the following formula:

Stiff Aluminum Bronze	
Copper	86 per cent
Aluminum	10 per cent
Iron	4 per cent

The copper is melted under charcoal in a crucible and when quite hot the iron is added in the form of loosely coiled pieces of tin plate. It is submerged as quickly as possible and followed by the aluminum. The castings are gated in a manner similar to where manganese bronze is employed and heavy feeders are provided to prevent shrinkage.

Tough Metal Required for Jet Pump Nozzles

We are making bronze throats for jet pumps employed in pumping mine water, but operated by water instead of steam. The operating water comes from the mountain with a head of 1600 feet and lifts the water from the mine 300 feet. Three gallons of jet water are required to lift one gallon of mine water. The water passes through the bronze throat under enormous pressure and at high velocity. Castings made from brass scrap only last a few days. We have tried the following mixture, but the castings only last about a week; copper 88 per cent, tin 5 per cent, zinc 2 per cent and "Bassite" 5 per cent. Our problem seems to center itself on finding a metal that will withstand the enormous pressure and the erosion of the water at the same time. One of the peculiar features is that several jets made from the same heat of brass will show a wide variation in the period they remain in service. Can you advance any explanation for this except possibly that the throats were not turned exactly the same as each other?

The alloy your are using at present is quiet soft and possibly a harder metal would have a longer life. Your present mixture closely resembles the metal from a standard formula, copper 89 per cent, tin 5 per cent, zinc 6 per cent, with a trace of manganese which acts as a deoxidizer. The United States navy standard alloy specified for hose fittings is copper 87 per cent, tin not less than 7 per cent, lead not more than 1 per cent, zinc 5 per cent. Possibly this alloy would render more satisfactory service. What you really need is an alloy with some of the properties of manganese steel. This metal is not hard but it is tough and is peculiarly well adapted to resist abrasive influence. You probably are familiar with it in the shape of steam shovel bucket teeth and other castings subject to either abrasion or shock or both.

No nonferrous alloy possesses the properties of manganese steel. Aluminum bronze presents the nearest approach and we believe that one of the alloys in the series will excel any other nonferrous alloy for this particular purpose. You might experiment first with the following alloy:

Strong, Ductile Aluminum Bronze	
Copper	88.50 per cent
Iron	3.50 per cent
Aluminum	8.00 per cent

The tensile strength of this alloy is 80,000 pounds or more and the elongation is 35 per cent or better. The brinell hardness number is over 100. The metal is strong, tough and hard and the only objectionable feature in connection with it is that like all aluminum bronzes, it is an extremely difficult metal to cast. The mold must be gated in a manner that will permit the metal to enter at the lowest point so that it may rise gently. The least agitation produces foam and in this case foam is only another name for dross.

Facing Sand Mixture for Brass Castings

Do you know of a preparation that can be mixed with molding sand to make it tougher and thus prevent it from cutting and scabbing in connection with red brass and aluminum castings. Our foundryman now is using a facing of flour and sharp sand mixed 1 to 12 or 16 for castings weighing approximately 100 pounds.

The iron foundryman mixes a carbonaceous powder, usually finely ground coal, with molding sand mixed with a proportion of new sand for facing on patterns. This facing may be used on brass castings, but is objectionable in some cases since it turns the skin of the castings dark. Foundry supply houses advertising in The Foundry are prepared to supply the material in various grades of fineness to suit different classes of work. Flour is employed freely in brass foundries for the same purpose.

Sharp sand alone is too weak for dry sand facing and for that reason it usually is mixed with about twice its bulk of molding sand, half new and half old. The sand is mixed while quite dry and if any flour is required it is added at the same time. After the sand has been mixed thoroughly it is wet down with clay wash to the proper degree for molding. That is water in which clay has been stirred until the mixture has assumed the thickness of cream. If this damp sand mixture can be passed through a facing mill it will make a tough and strong facing for dry sand work. Flour usually is added to the sand in the proportion of 1 part flour to 20 sand.

Hard to Break Aluminum Bronze Castings

We have on our hands some large aluminum bronze scrap castings and are at a loss to know how to remelt them. They were cast from an alloy containing copper 90 per cent and aluminum 10 per cent. This metal will forge at a red heat. We shall appreciate your suggestion on how to break these castings into pieces so small that we can remelt them.

You will have an expensive job on your hands if you attempt to cut them up. They may be broken if heated to a sufficiently high temperature. Aluminum bronze may be forged at a temperature where copper-tin alloys crumble to pieces. Sledging them at this temperature merely batters them and represents labor lost so far as breaking them is concerned. However, if the heat is continued the bronze will crumble readily.

The castings will have to be raised to a bright red heat. At this temperature that part of the alloy constituting the cement which holds the crystals together, melts. At this point if the skin of the casting is broken by a blow from a sledge, the crystals come tumbling out like peas from a pod. Solid masses of bronze, for example, a solid cylinder 8-inches diameter, 12 inches long, readily may be split into its individual crystals in this manner. Given the proper temperature and some quick work with a sledge and the clumps of crystals easily are separated as they roll out.

How British Cast Aluminum

Precaution for Melting Given and Different Alloys Considered—Methods Described for Molding Spiral and Cylinder Head for Airplane Motor, Together with Crankcase and Other Types of Castings

BY E. H. TYSON

THE aluminum alloy consisting of 12 per cent zinc, 3 per cent copper, with the remainder aluminum, is a good mixture for crankcases, or any other casting requiring a high tensile strength and elongation. It is easy to increase the tensile strength by adding more zinc, but that would be at the expense of the elongation. Zinc to the extent of 20 to 25 per cent is easily alloyed with aluminum but could be used only for the less important castings on account of its liability to crack and break under vibration. An aluminum of not less than 98.5 per cent purity should be used for alloying. The iron impurity should not be more than 0.5 per cent. It is also of great importance that the zinc and copper be of high purity and that the copper be free of arsenic. This alloy is also improved by introducing from 0.1 to 0.5 per cent manganese, making the material tougher and more easily machined. The manganese should be introduced as manganese copper. Manganese up to 0.5 per cent increases the strength and helps to reduce cracks in the castings, but spoils the appearance, making the metal a dull gray. It also is rather an expensive metal to use. The metal for the 50-50-aluminum-copper alloy is first melted in a plumbago crucible, run into ingots, then the amount required to bring the mixture up to the correct copper content is added. The zinc is introduced into the aluminum-copper alloy just before the metal is ready for casting. The pouring temperature for any casting should not be more than 750 degrees Cent. That temperature would be too high for crankcases or gearcases for which 670 to 700 degrees Cent. is recommended.

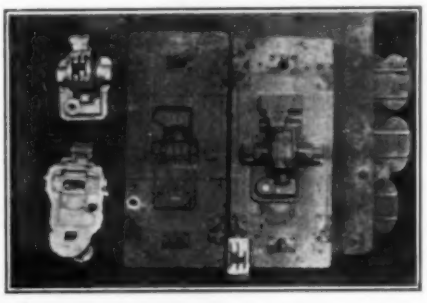


FIG. 3—GEAR-CASE COVER PATTERN AND COREBOX

The temperature of the metal should be taken with a pyrometer as it can not be judged closely by the eye. If the temperature of the metal in the ladle is too high the metal should be allowed to cool until the proper temperature is reachel. The metal should not be cooled by dropping in small scrap such as runners and risers, as is sometimes practiced in many foundries.

Several types of furnaces are used for melting aluminum. The author has had most experience with tfie type of furnace in weich five pots, each holding 500 pounds of metal are used. The fastest melting pot is No. 2, next to that No. 3 and then Nos. 4, and 5 respectively. Owing to the fact that crucibles No. 2 and No. 3 are faster than No. 1 the author does not favor the single pot furnace.

During the latter part of the war we had to use what was called the 50-50 fuel, consisting of 50 per cent crude oil and 50 per cent pitch, and this proved successful. Of course we had to keep the oil at a fairly high temperature, or we soon should have had a stoppage in the pipes. The blast is from a blower with a 3-inch pipe and a pressure of 2 pounds. The oil is fed by gravity from an overhead tank.

Although the jar-ram type of molding machine is preferable for most classes of work it is well to have different makes of machines, as no one make suits all the different types of castings which have to be produced in a foundry.

We have used a small jolt core machine for making molds for an air-cooled aluminum cylinder. This was a pattern where only a few were wanted and it was impossible to ram by hand and get a good lift, the fins

Abstracts from a paper presented at a recent meeting of the Birmingham branch of the Institution of British Foundrymen. The author, E. H. Tyson, is foundry manager, William Mills, Ltd., Atlas Aluminum Works, Birmingham, England.

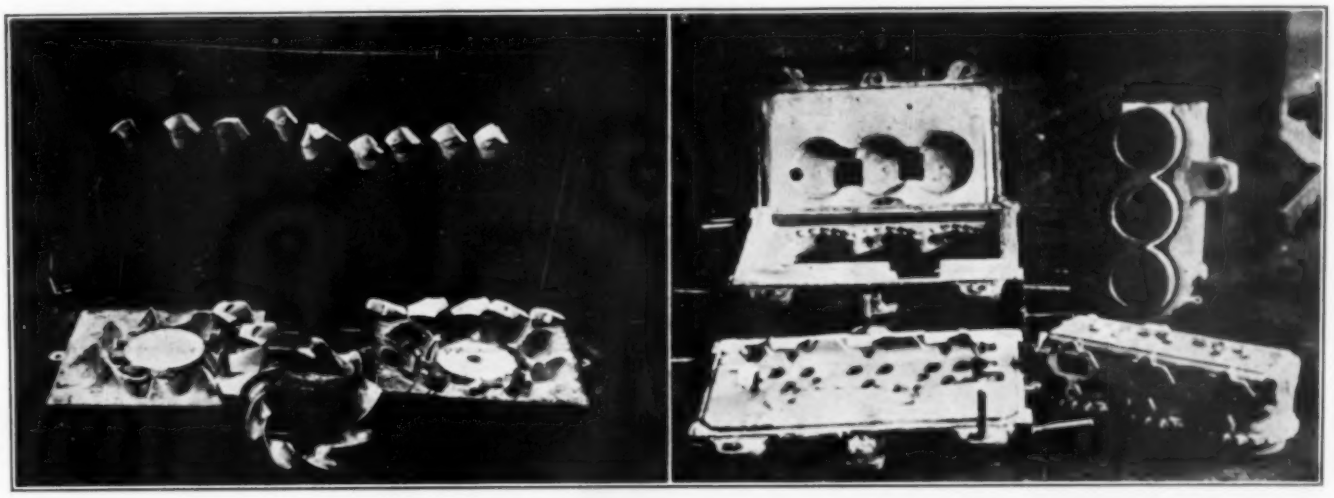
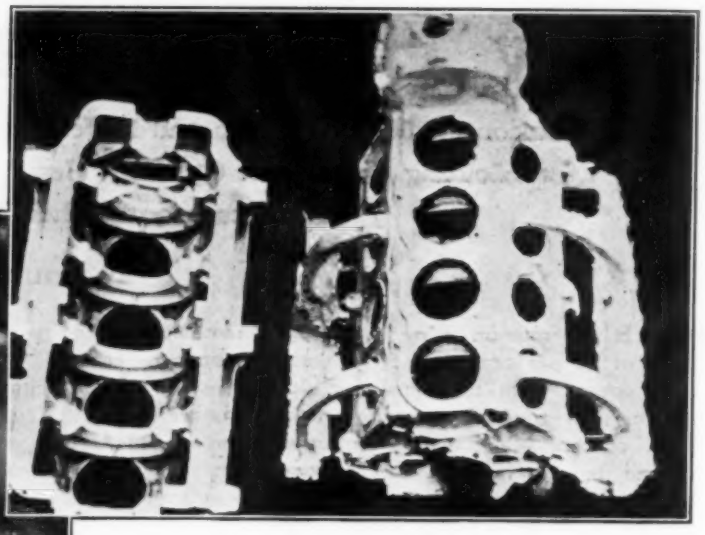
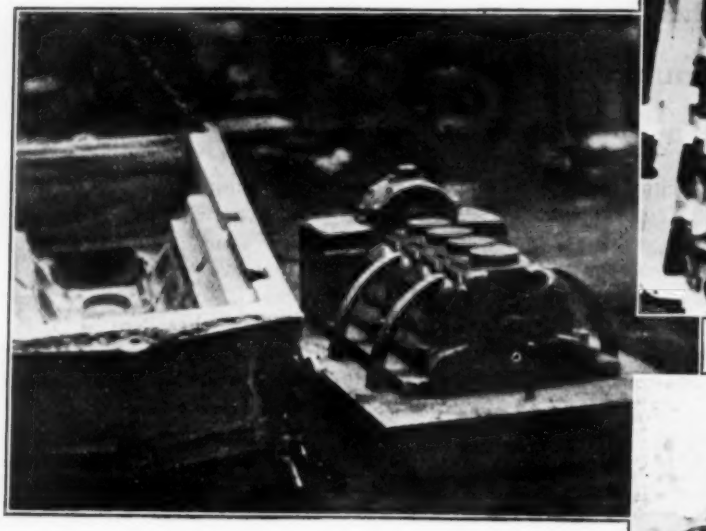


FIG. 1—MOLDING A SPIRAL FOR AN AIRPLANE ENGINE IS A COMPLICATED JOB FIG. 2—CYLINDER HEAD FOR AN AIRPLANE ENGINE MADE WITH A N ALUMINUM-COPPER ALLOY

FIG. 4—BELOW—PATTERN AND DRAG FOR A CRANK-CASE WHICH IS POURED THROUGH HORN GATES FIG 5—AT RIGHT CASTINGS MADE FROM THE PATTERN SHOWN IN FIG. 4





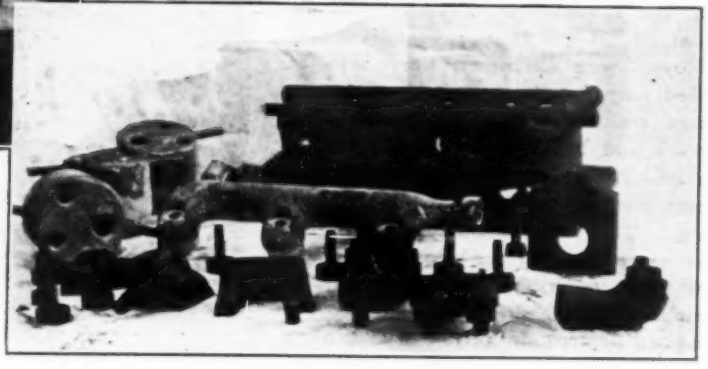


FIG. 6—AT RIGHT—CORES FOR THE CYLINDER HEAD SHOWN IN FIG. 2—THESE ARE BONDED WITH OIL

being too deep. The one half pattern was placed on the machine with the wood frame around it, leaving just enough space for sand, and rammed. The frame was taken off and a flask was placed on the machine, filled with sand and rammed, but not heavily. This was then turned over showing the joint. The other half pattern was put on the machine and rammed the same way in the wood frame. It then was placed on the first half mold and the frame removed; a flask was set on and rammed as before; then the flask was parted and the pattern drawn, the object of this was to enable the dowels to be used, and so insure the two halves of the pattern coming togther.

Fig. 1 presents a rather complicated job for hand molding. It is a spiral for an airplane engine. The casting is shown between the two halves of the mold. In all 18 cores and 9 drawbacks are required. The spiral resembles a three-blade screw. The inside of the screw is cored in the way shown and the drawback takes the outside top and bottom. The casting is run from the inside by a spray.

Fig. 2 represents a cylinder head for an airplane engine. The drag is an intricate job. The casting is made of an aluminum-copper alloy containing 7 per cent copper. We recently read an article on aluminum molding which, in referring to this alloy, says the cores must be released as soon as possible after casting to avoid cracking. However, we have not found this to be the case. These castings often are left in the sand until they

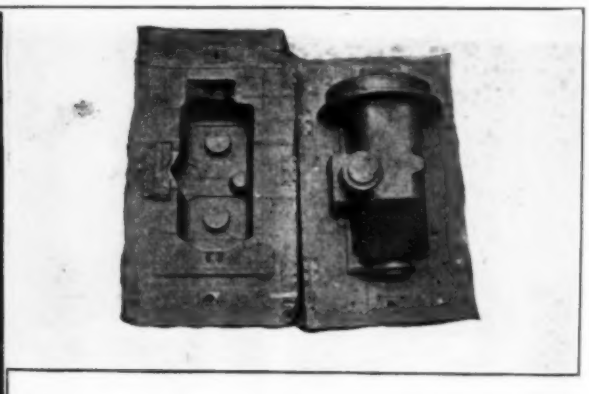


FIG. 7—AT LEFT—MOLD AND CORE FOR A LARGE ALUMINUM PAN—A DISCARDED PAN WAS USED AS A PATTERN FIG. 8—ABOVE—OIL-BASE PATTERN AND CORE-BOX MOUNTED ON BOARDS

are cold and no trouble with cracks has developed.

The cores for this casting, all of which are bonded with oil, are shown in Fig. 6. If these were cast in a zinc-copper-aluminum alloy it would be necessary to release the cores soon after solidification.

Fig. No. 4 shows a pattern and drag for a crankcase indicated in Fig. 5. The casting was poured with horn gates. This system gives the air a chance to escape and helps to eliminate air traps. No risers are employed, but air vents are allowed through the top and feeding heads are located on the feet and flange. The heads are cut off by a horizontal band saw. We do not believe in risers, and eliminate them where possible although the majority of molders like to put as many as they can on the top of a casting. Apparently there is some fascination in pushing a tube through the sand, but we do not know why this should be.

The mold and core for a large aluminum pan are shown in Fig. 7. The mold was made off a discarded pan and rammed in the floor. The core was rammed on a grid, bolted to the cross in the manner shown. Stakes were driven into the floor as a guide for the cross and cores were placed around to form a flange. This is a quick method of making a pan of this description. A prop was set from the top of the cross to the crane overhead to prevent the core lifting when casting.

Fig. 8 shows an oil-base pattern and corebox, both mounted on boards. With this system of molding it is possible to use mostly unskilled labor, and it also represents a big economy in pattern repairs. We have made 500 castings off this pattern and corebox without any repairs whatever, and expect to get another 500 before they go into the pattern shop. Of course, with this type of molding all the flask parts must be interchangeable.

A change-speed gear-case cover pattern on a board is shown wih its corebox in Fig. 3. The core for the change-speed slots is placed in the pattern and rammed in the mold. This being an oil-sand core, make clean slots. This method is much easier than trying to draw the slots, or to put them in the internal core. With this method a boy can make good castings, whereas if a loose pattern were used the job would have to be made by a man, with perhaps a reduction in the number of castings. However, few loose patterns can be molded in this manner.

One type of flask used is made of aluminum. The sides and ends are cast separately and then bolted together. The bars are bolted in to suit the particular job required. We have a standard size 6 x 9 x 12 inches. If a wider or narrower box is wanted we take them to pieces and put in what ends are needed. The bushings are run in with white metal using a master flask.

Most aluminum foundries use wooden flasks but these are expensive, they get burned, the pins become loose, or they become strained when lifted, often cracking the mold and causing a big percentage of scrap. Wooden flasks are much heavier than those made of aluminum.

Blowholes are often caused by excessive dampness of sand, by moisture on chills, or through cores not being properly vented. Many believe that cores and molds for this method do not require venting. However, experience has shown us that there cannot be too much venting. Air traps often are called blowholes, and occluded gasholes in the metal, which may or may not be the result of overheated metal also are sometimes termed blowholes. Absorption of gas by the alloys increases with increasing temperature and the gases absorbed are often held in solution until solidification commences.

Porosity is often caused by insufficient venting. We remember some castings we were making with a rather thin pocket of sand in the green-sand core. Each casting had the same defect, suggesting a marked segregation of the metal, and similar in appearance to wood which had been wormeaten. The cause of this was the mold being improperly vented. When the metal came in contact with the hard-rammed sand there was a small puff of gas just sufficient to disturb the metal before solidification. The defect was overcome by putting a vent in this particular part.

Another cause of porosity is segregation of the metal. This trouble will often be found on the crown of an aluminum piston which, when machined, shows fine lines and pinholes. This is a trouble which can be overcome by chilling. Many troubles are traceable to cores. It is as well to use geen sand wherever possible because of the greatly decreased production costs, especially in large castings. Cracks are often traceable to cores which are too hard, or the heavy parts may not be properly chilled. The trouble also is likely to arise if the gate is placed too near a heavy section. With a heavy piece of metal it is sometimes found, when the casting is taken out of the mold, that there is a sink in it. If a riser is put on, no matter how large, there is often a draw because of the riser cooling more quickly than the heavy metal underneath.

It looks quite simple to make a tube 4 to 5 inches in diameter and 12 inches long, with ⅜-inch metal. Many would try to make this on end. But it is possible to have a porous, dirty casting. We overcame this trouble by casting horizontally and adding a strip which easily can be cut off. Another job which is not easy to get free from blowholes is the casting of a drum 3 feet in diameter, 12 inches deep, and with a ⅝-inch section. The best method of pouring is to have four wedge runners, and allow the metal to fall to the bottom of the mold and gradually rise to the top with enough vents in the cope. It is well to run chills down the sides of the runners because of the heavy section at certain points.

Book Review

Foundry Work, by R. E. Wendt, cloth 206 pages 7½ x 4¾; published by McGraw-Hill Book Co., Inc., New York and supplied by THE FOUNDRY, Cleveland, price $2.00.

This volume is a text book of foundry practice including the subjects of molding, dry-sand, coremaking and the melting and mixing of metals. Its preparation was undertaken to provide a suitable text for schools and colleges and for use by apprentices in commercial shops. The subjects discussed are divided into three sections; fundamental principles, exercises and problems in molding, and the melting and mixing of metals.

The first section is devoted to an outline of foundry practices from the making of the iron in the blast furnace to the methods of treatment and the underlying theories of casting. A few of the topics in this section are molding sand, commercial foundry layouts, foundry cokes, flasks, and similar subjects. The second section deals with the molding problems and unusual methods necessitated by various patterns as well as the details of dry-sand core making and floor and bench molding. The last part of the book deals with the construction and operation of cupolas, the analysis of the molten iron, and nonferrous metal founding. A set of tables, a glossary of foundry terms, and an index conclude the book.

Some of the material contained in this volume is a direct result of the author's experience in teaching apprentices in commercial shops and engineering students at Purdue university.

Observes Melting in Cupola

Conditions During the Heat Observed Through Holes in the Cupola Shell Indicate Melting Takes Place Over Extended Length Depending on Variation of Sections of the Stocks

BY JOHN GRENNAN

IT HAS been quite generally believed that in melting cast iron in a cupola, there is a limited section of the cupola in which melting takes place. This section is usually referred to as the melting zone. It is also a more or less accepted idea that the melting is fairly uniform in horizontal sections of the melting zone.

A. W. Belden* presents the idea that the melting zone should be not lower than 19 inches above the tuyeres under the conditions with which he worked. He says, "Experimental determination of this region is not necessary. In practice the bellying out of the lining of the cupola is a perfect index of the position of the melting zone, and this bellying is in the region where temperature is highest and oxygen is absent." This locates the lower limits of the melting zone quite satisfactorily.

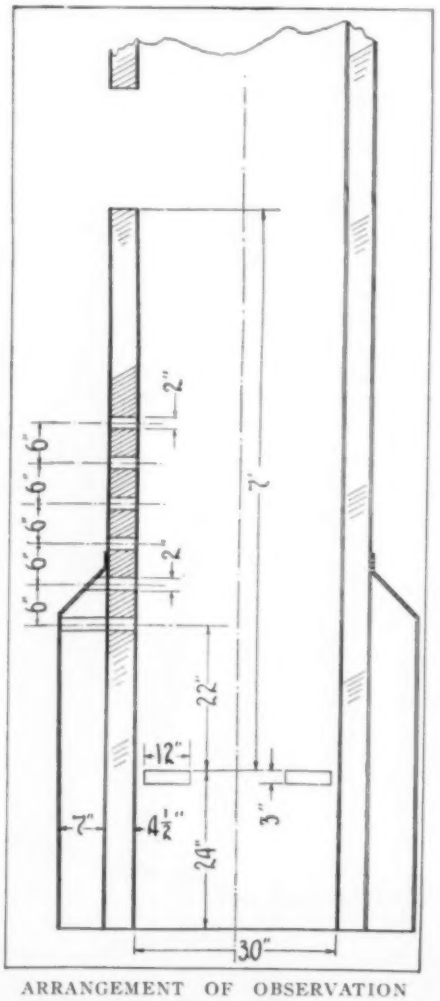
Dr. Moldenke stated in a paper before this association at its convention at Rochester last year: "The only conclusion to be derived is that melting takes place much higher than is supposed along the lining." This leaves the top of the melting zone quite indefinite.

Observing Melting

To watch the process of melting in the cupola at the University of Michigan holes were cut in the side of the cupola. The cupola is shown in cross section in the accompanying illustration. It is 30 inches in diameter inside the lining. The holes, six in number, with centers 6 inches apart, are placed in a vertical row with the bottom of the lowest hole 21 inches above the top of the tuyeres. There are four tuyeres, 3 x 12 inches. The charging door is 7 feet above the top of the tuyeres and 9 feet above the bottom plate. The fan used was made by the American Blower Co. The air volume measured about 1500 to 1600 cubic feet per minute.

It was found that the holes slagged over soon after melting began, when they were shaped up with the daubing clay used in daubing the cupola. To overcome this, a small clay crucible was placed in the hole so as to project about a half inch into the cupola beyond the lining. The abrasion of the descending stock kept the holes open. A window of mica was placed over the outer end of each hole to prevent the escape of hot gases. It was also found advisable to put in a sheet iron shutter to prevent smoke from covering the windows.

The following method was used in charging: The fire was started with wood and the bed charge of coke brought to 28 inches above the tuyeres. The iron charges weighed 700 pounds, 50 per cent pig and 50 per cent scrap or all scrap iron, with 75 pounds of coke between charges, (three to five charges to a heat).



ARRANGEMENT OF OBSERVATION HOLES THROUGH CUPOLA SHELL

The depth of the bed charge of coke brought it to the second hole. The depth of the iron charges varied from 7 inches to 18 inches, depending on the nature of the scrap iron. Light cored castings such as automobile cylinders, pistons, and gates increased the depth when compared to heavy flat scrap. The coke charges above the bed charge were estimated to be 6 inches deep. When measured they were found to vary from 6 to 7 inches.

Obtaining Temperature Data

An optical pyrometer was used to determine the temperature at the openings. There was considerable variation in the readings, due to lack of uniform conditions in the cupola. The temperature of the gas could not be taken. It was necessary to focus on a solid object and the size and contact with colder objects influenced the temperature of the piece. The readings were taken on the hottest piece of coke in view. Although the temperatures read were lower than the gas in the cupola at that point, they showed, to quite an extent, the rapid heating of the stock in the melting zone. The temperature readings were taken on the four holes just above the tuyeres. Table I is a typical record. Table II is an average for five heats.

The highest temperatures recorded were no doubt much nearer the real temperatures than the average temperatures. The higher the reading was taken in the cupola the less reliable the results, due to contact with colder objects and the shorter time exposed to the hot gases.

The temperatures taken showed that from 21 inches to 40 inches above the tuyeres the gases were hot enough to heat small pieces of coke above the melting point of cast iron.

A base thermocouple was placed in the cupola at the charging door. The end of the couple was about a foot below the charging door so that the burning of the gases with the air at the charging door would not influ-

Paper presented at the convention of the American Foundrymen's association, held in Cleveland, April 28 to May 3. The author, John Grennan, is instructor in foundry practice, University of Michigan, Ann Arbor, Mich.

*Transactions A. F. A., Vol. 22, page 33.

Table I

Temperature Readings

Time	No. 1 Degrees Fahr.	No. 2 Degrees Fahr.	No. 3 Degrees Fahr.	No. 4 Degrees Fahr.
3:05	2782	2910	2515	2135
3:10	2862	2808	2285	2098
3:15	2782	2555	2560	1980
3:20	2790	2390	2429	2005
3:25	2738	2528	2502	2105
3:30	2905	2720	2703	2320
3:35	3085	3040	860	2525

ence the temperature. As the length of time charging kept the stock as high as the charging door was short, these temperatures could not be considered reliable. The record showed a rapid increase from about 250 degrees Fahr. when the blast was put on to about 1575 degrees Fahr. 8 minutes later. Table III gives the temperature records at the charging door for three heats.

The temperatures taken gave little indication of what takes place in a cupola. It was possible by wearing smoked glasses to see a great deal of the process of melting. As there is considerable space between the iron and coke as charged into a cupola, it was possible to see varying distances into the cupola. These distances varied from openings that reached to the center of the cupola or beyond, to the complete closing off of the opening by a piece of coke or slag. Notes were made of the conditions observed. The notes from any heat were always incomplete for several reasons, the chief ones being those already given. The experience gained in repeated observations made it possible to see more clearly what was going on.

Table II

Average Readings from Five Heats

	No. 1 Degrees Fahr.	No. 2 Degrees Fahr.	No. 3 Degrees Fahr.	No. 4 Degrees Fahr.
Average temperature.....	2800	2638	2370	2213
No. of readings	40	37	41	20

Melting was observed to extend from the lowest hole, 21 inches above the tuyeres, to the fifth hole, 46 inches above the tuyeres. This was the widest range of melting that was observed. The heat consisted of three charges. The first charge was 50 per cent pig and 50 per cent scrap and weighed 700 pounds. It was 9 inches thick and on a 28-inch bed charge of coke. The second charge was 80 pounds of coke and 800 pounds of iron. The iron was medium weight and light scrap consisting of shop pigs, gates and risers. The coke was 6 inches deep and the iron 11 inches deep. The third charge consisted of 80 pounds of coke and 800 pounds of light gates. The coke measured 7½ inches deep and the iron 17 inches. The blast was put on at 10:45 a. m. and the observations were made between 10:53 and 10:58 a. m. These are similar to a great many observations except that melting was not observed above the fourth hole in the other heats.

The following are the notes taken during this heat:

The holes in the cupola were numbered from bottom to top. The time indicates beginning of observation.

Time a. m.	Hole	
10:53	1,	Pig iron melting
	2,	Scrap iron melting
	3,	Coke and iron mixed. Iron melting
	4,	Coke and iron. Iron melting.
	5,	Scrap iron melting
	6,	Coke red hot
10:58		Blast off
	1,	Scrap melting
	2,	Coke. Iron dripping down
	3,	Scrap iron melting
	4,	Coke and scrap iron, scrap iron red hot
	5,	Scrap iron dull red
11:04	1,	Coke. Iron dripping down
	2,	Coke. Iron dripping down
	3,	Scrap iron melting
	4,	Scrap iron. Small pieces just beginning to melt
	5,	Top of scrap red hot
11:09	1,	Scrap iron, all pieces melting
	2,	Scrap iron melting
	3,	Top of scrap red hot
11:11	1,	Scrap iron melting
	2,	Scrap iron melting
11:13	1,	Last of scrap melting
11:15		Blast off—end of heat

The following is another set of notes on observations made where the range of melting was not as wide as in the one just given:

The bed charge of coke measured 28 inches above the tuyeres. The bed charge of iron consisted of 700 pounds of iron, 50 per cnt pig and 50 per cent medium weight scrap iron. The depth of the iron charge was 10 inches. The second charge consisted of 75 pounds of coke and 700 pounds of iron. The iron was 50 per cent pig and 50 per cent scrap, the same as the first charge. The third and fourth charges each consisted of 75 pounds of coke and 700 pounds of medium and light scrap iron. The fifth charge consisted of 40 pounds of coke and 400 pounds medium weight scrap iron.

Blast on 3:02 p. m. Holes were numbered from bottom up.

Time p. m.	Hole	
3:03	1,	Coke
	2,	Coke. Red hot pig in contact with coke
	3,	Scrap, dark red
	4,	Scrap, dark red
	5,	Scrap
	6,	Coke
3:08	1,	Coke
	2,	Coke and melting pig
	3,	Red hot scrap partly melting around side of cupola
	4,	Scrap red hot
	5,	Coke
	6,	Coke
3:15	1,	Iron dripping down through coke.
	2,	Melting scrap and coke
	3	Melting scrap and coke
	4,	Melting scrap
	5,	Coke
	6,	Iron red hot
3:23	1,	Coke
	2,	Coke
	3,	Coke and melting iron
	4,	Melting iron
	5,	Coke
	6,	Scrap small pieces red hot
3:30	1,	Coke. Iron dripping down from above
	2,	Blocked with coke
	3,	Scrap melting, outside melting faster than in center of cupola
	4,	Coke and melting scrap
	5,	Coke
	6,	Coke
3:40	1,	Coke
	2,	Coke and melting scrap
	3,	Melting scrap
	4,	Red hot scrap
	5,	Red hot scrap
3:47		Blast off

The foregoing observations were made by students. A large number of similar observations were made, some more complete in other details not given clearly in these reports. It was desired to get as accurate a statement of what was seen as possible, rather than an interpretation of what was taking place.

Summing up reports and using his own notes, the writer can state definitely that the following occurs in the cupola under the conditions given:

Melting takes place as low as 21 inches above the tuyeres and extends to as high as 46 inches above them. The highest melting occurs at the lining and consists of the lightest scrap. The last pieces to melt are always at the center of the cupola and are the remains of the heavier pieces. Pig iron (machine cast was used) begins to melt near the lining about 34 inches above the tuyeres, the edges rounding off first. At 28 inches above the tuyeres, pig iron near the lining

Table III

Temperature Readings at Charging Doors

Time	Temperature Degrees Fahr.	Time	Temperature Degrees Fahr.	Time	Temperature Degrees Fahr.
11:10	100	3:29	245	2:29	235
11:15	765	3:30	425	2:30	425
11:20	1465	3:33½	1175	2:33	1175
11:25	1405	3:35	1385	2:35	1360
		3:37½	1575	2:37	1575
		3:39	1545	2:39	1545
		3:40	1525	2:40	1325
		3:41	1505	2:41	1505

melts rapidly. The melting in the center is about 6 inches lower than at the lining, at the 22-inch and 28-inch levels. An average sized piece of pig iron will take about 6 minutes to melt and will settle 6 or 8 inches in the cupola while melting.

The stock in the center of the cupola is visibly colder than at the lining. The higher in the cupola the greater is the difference in temperature between the stock at the center and the lining. Compact charges of iron, uniform in size, reduce the range of melting. There is considerable mixing of the coke and iron in their descent in the cupola.

The causes that contribute to the results may be worth considering. The wide range in melting is due to three or four conditions. One is the speed of the gases through the stock which carries heat high above the supposed melting zone. Another is the fact that the space between the coke at the lining is greater than in the center. This may be accounted for in two ways. The stock in descending shifts and adjusts itself more compactly in the center while the lining has a tendency to retard and open the stock. In throwing iron into the cupola, the blows pack the center more than at the lining. A third reason is the one given by A. W. Belden.* He shows that combustion in the cupola occurs below the surface of an inverted cone, which has its apex at the center of the cupola level with the bottom of the tuyeres and its base at the lining, 19 inches above the tuyeres. He gives as the probable line of highest temperature a modification of this cone with the apex cut off about half its height, or 10 inches above the tuyeres at the center of the cupola. Another fact that would carry the heat higher at the lining is that the lining soon gets heated to a high temperature and ceases to absorb heat to any extent but reflects it back into the stock.

Judging from what was observed the following conclusions seem justified:

Upper tuyeres would tend to increase an undesirable condition in the cupola and should not be used. Upper tuyeres would increase the difference in temperature between the center of the cupola and the lining. A center tuyere, if practical, would be desirable.

Wide variations in either thickness or analysis in the pieces of metal charged should be avoided. Light scrap iron at the lining, may begin to melt 24 inches higher in the cupola than the last piece of pig of the same charge completes melting at the center. The light scrap of the second charge will be mixed with the charge below it or possibly the last iron of one charge to melt may be mixed with the first iron melting from the second charge above it. Iron in three charges is often melting at one time. The use of ferromanganese or high-silicon pig iron in the cupola, to raise these elements is likely to lead to variation in the analysis of the metal. If high-silicon pig iron was used as a softener, and in one charge happened to be charged into the center of the cupola, and the next near the lining, it would melt at about the same time in both charges.

A receiving ladle with the capacity of at least one charge should be used. If the scrap iron is less in cross section than the pig iron, and this is usually true, a larger proportion of scrap will be found in the first tap than is representative of the first charge. This is no doubt partly responsible for the general opinion that the first tap is inferior to the others.

*Bulletin 54, bureau of mines, pp. 17, 18.

Advocates Rapid Pouring of Castings

BY THOMAS NELSON

While reading Charles Vicker's article in a recent issue of THE FOUNDRY on the methods pursued in the production of large bronze bushings the subhead *Spattering Avoided* reminded me of a somewhat similar instance which came under my observation in a shop to which I had returned about seven years after I had served my apprenticeship. The casting I have in mind was not a bronze bushing, but a cast iron plate 4 feet square, 1 inch thick, but the trouble was the same and the remedy applied corresponded with those described by Mr. Vickers.

The plate was plain on both sides and although the specifications called for a perfectly clean surface on both sides after it was machined, no trouble was anticipated. Twelve plates were ordered and since they had to be shipped a considerable distance the entire number were shipped at one time. They were made in strong iron flasks and were poured from two bull ladles through two basins feeding two pop gates at opposite ends. The castings in the rough looked perfect, but after a short time the entire lot was rejected and returned by the customer. The first cut of the tool over the drag face of the casting revealed innumerable little pellets about the size of buck shot and so hard that no tool could touch them. They were grouped mostly around the edge of the plate.

Clearly, they were produced by the metal spattering when it entered the mold and the drops solidified before they were covered by the iron.

I was making some tables 12 x 6 feet with heavy ribs on the under side. I poured them with a 2-ton ladle through a number of pop gates directly over the ribs and filled the molds so rapidly that the man engaged in making the square plates the second time was moved to comment on the speed, and further was induced to try the same method. Instead of two small pop gates at opposite ends, he provided two large upright runners on the joint and then cut several generous gates leading into the mold. He filled the molds rapidly with fairly hot metal and the second set of plates machined perfectly clean. I always have maintained that a mold should be filled as rapidly as the metal can be poured into it.

A mold must be prepared properly to stand up to the strain entailed by rapid pouring. The sand must be strong and also must be of the proper analysis and in addition sea coal must be present in sufficient quantity and in proportion to the weight of the casting. The mold must be blacked intelligently, the flask must be rigid, the gates and runners correctly placed, the sand must be rammed to the proper density and the mold must be vented. A vent wire is the most essential tool in a molder's kit, but it must be used with discretion and intelligence. Many an otherwise good mold is ruined by a careless use of the vent wire. One vent hole properly placed is of more value than a baker's dozen if twelve of them are so placed close to the face of the mold that the metal gets into them and defeats the object for which they were intended. If the foregoing points are observed and the mold filled quickly no trouble will be experienced from spattering metal.

Core Oil Complex Compound

Properties of the Various Oils Used in the Production of Core Oil Are Described —Functions of the Binder Shown to be Affected by Grade and Condition of Sand Used

BY WERNER G. SMITH

CORE oils are used for cores which must withstand moisture, and for cores which must be removed easily from castings. Cores made from this class of binder may be stored for long periods of time without deterioration. Intricate and delicate cores are made with oil binders.

The leading use of oil is for castings for automobile cylinders and other parts, high-speed combustion engines, hot water and steam radiation, boilers, stoves, furnaces, farm implements, malleable and gray iron fittings and every other kind of casting where moisture-proof cores are required, which in turn can be stored and which easily can be removed from castings.

Core oil is made of vegetable oils, gum rosin, imported fossil gums, and light mineral oils. A number of vegetable oils also are used, the principal one being linseed oil. Some of the other oils are China wood oil, corn oil, soya bean oil and any other drying oil which has a high iodine and good film value. Iodine and film values are closely linked together in that any oil with a high iodine value usually has a good film value and for this reason the iodine value of an oil is an expression of its quality.

Unlike most vegetable oils linseed is a world commodity being produced in various centers of which the principal are the American Northwest, Canada, Argentine, India and, under normal conditions, Russia. The Argentine is by far the largest producer of flaxseed, or linseed, from which the oil is pressed, having an annual crop of approximately 50,000,000 bushels. The normal American crop is approximately 15,000,000 bushels, and the Canadian crop 7,000,000. As contrasted with production, the normal consumption in the United States is approximately 35,000,000 bushels, or better than twice the production. Canada normally has a small exportable crop to this country but 50 per cent of our requirements each year come from the Argentine republic.

It may be of interest to consider that at the present time our government has an import duty of 40 cents per bushel on flaxseed and 26 cents per gallon on linseed oil. Formerly a great deal of linseed oil was imported to this country from England and other European countries, but with such a heavy duty on oil, importation is practically eliminated.

A bushel of flaxseed produces 19 pounds of oil. With a consumption of 35,000,000 bushels of seed our consumption of oil today is approximately 88,600,000 gallons of oil. The bulk of this oil goes into the paint and varnish, linoleum, cork, and core oil industries.

Other Varieties of Oil

China wood oil is a distinctly Chinese oil, produced only in China. It is an ideal drying oil, has a wonderful film value and is indispensable in some lines of industry.

Corn oil is manufactured from the yellow germ of the kernel of corn and is primarily an American product. It is classed as a semidrying oil, has a fair film value, but is not used to any great extent as a film oil. The principal use of corn oil, except for soap making, is for edible purposes. It refines colorless and odorless, and makes a splendid cooking oil.

Soya bean oil is another distinctly Chinese oil, produced from the soya bean, which is similar to the American navy bean except that it is brown in color and contains approximately 30 per cent oil. Soya bean oil has a fair iodine value and film value and is used to a considerable extent in connection with linseed oil as a film oil. However, the principal use is in the production of hydrogenated lard compounds. Because of its competition with cotton seed oil for lard compound there is an import duty on bean oil of 2½ cents a pound or 20 cents a gallon. This has materially checked its importation.

The rosin used in core oil is principally gum rosin distilled from sap collected from the pine trees in the South. The sap collected from pine trees produces, when distilled, gum turpentine, pine oils, rosin oils, and rosin. Rosin is produced in various qualities which are indicated by their color. These qualities are classified according to the letters of the alphabet from *A*, *B* and *C* to necessary to maintain a well equipped *WW*. *A*, *B* and *C* are the lowest grades and dark in color, containing considerable dirt, while *WW*, sometimes called *window white*, is as the name implies almost colorless and entirely free from dirt. The grades most generally used for core oils are *E*, *H* and *I*, sometimes called Edward, Harry and Isaac. *E* grade rosin is dark red, *H* and *I* are straw color.

The imported fossil gums used are standardized to a much less extent than rosins, and differ radically in texture. Whereas rosins are fairly soft and brittle, gums are hard and flintlike. Fossil by nature, gums are collected from the ground in various parts of the world, chiefly in South America. They are scraped thoroughly and cleaned before being imported into this country. They vary in color from dark to window white. Being almost as hard as glass they make a tough film which recommends them for core oil and, because of the toughness and durability of their film value, fossil gums are almost indispensable for the manufacture of high grade varnishes, enamels, etc. Generally speaking all of the best varnishes are made from one or another kind of fossil gum, and it is for this reason that such varnishes are durable, hard and rich in depth of appearance. The subject of fossil gums is an interesting one filled with romance because of the fact that they come from the most uncivilized places of the earth.

Mineral Oil An Ingredient

In addition to various chemicals which are used in the manufacture of core oil, the next important material is mineral oil, various qualities of which are used depending upon the manufacturer and the kind of core oil desired. Intelligent selection of mineral oil is important as it seriously affects the workability of the oil not only in the corebox but in the time of baking and in the gas and smoke generated in the oven.

The process of making core oil is not so difficult as it is particular. The essential thing is to know the raw materials and have means and methods of standardizing the products so that it is possible to turn out the same grade of oil at all times. First of all it is laboratory to be certain that all in-

Abstracts from a paper presented at a recent meeting of the Detroit Foundrymen's association. The author is president of the Werner G. Smith Co., Cleveland.

coming materials are of the proper quality and uniform. Then it is necessary that proper technical men supervise the treatment of raw vegetable oils before they are actually made up into core oil. The second step in making core oil is to treat rosins and gums with chemicals and mineral salts to increase the toughness of the film. The treated gums and vegetable oils are then dissolved together in direct open fire kettles and given special treatment to increase their oxidation, viscosity, etc., and finally, neutral mineral oils in various amounts, according to grade, are added to bring the viscosity of the finished oil to a proper working consistency.

There used to be a false impression that the manufacture of core oil was a simple and unimportant process and there was serious question whether or not anything of value really was accomplished with the average treatment of raw materials in core oils or similar compounded oils. This impression rapidly is being dispelled.

It is an established fact that raw linseed or any other drying oil after being thoroughly dissolved in gums and brought to a certain viscosity can be thinned by a proper agent such as turpentine or light mineral oils and produce a better film value than the raw material used before treatment. China wood oil, or tung oil as it used to be called in China, is a splendid example. The raw oil has practically no film value, but when properly boiled and treated in an open kettle it has a high film value, luster and adhering quality. It is superior to all other oils used in the paint and varnish industry for its drying qualities and the durability and extent of its film value.

Now that we know something of its composition, let us consider the chief function, is to cover each individual grain of sand with a thin film of oil. Capillary attraction then draws the oil to the point of contact of one grain of sand to another where it is solidified when dried in an oven, thus cementing the grains firmly together. The oil being drawn to the point of contact of the grains leaves the spaces or voids between the grains open and thus furnishes avenues for the free escape of the steam, smoke and gases generated when the metal is setting.

Function Considered

To get the best results from a core oil, core sand should be free as possible from loam, as loam fills up the spaces between the grains and prevents the oil from being drawn by capillary attraction to the points of contact. Loam acts as a sponge to core oil, not only holding the binder between the grains, but clogging the air spaces. The cores also are greatly weakened from the inherent weakness of the loam. When you stop to consider that a core mixed 1 to 65 generates 1600 to 1850 per cent greater volume of gas amounting to 16 to 18½ times the volume of the core it is quickly realized that the voids or spaces between grains of sand should be kept open to allow free escape of gas.

The requirements of a good core oil are many. Above everything else it must be moisture proof. It must dry thoroughly from the top to the bottom of the core. It must have a film value strong enough to make a strong bond in a great quantity of sand, for the ultimate achievement is a maximum strength with a minimum of oil coupled with durability and porosity. Core oil must be constructed so as to meet the ideal condition in the foundry from the standpoint of baking in the ovens, workability on the core bench and in the corebox. This question of oxidation is often misunderstood. A good oil must not oxidize so rapidly that it gums the corebox and dries on the benches, and yet must oxidize sufficiently soon to bake in a core oven in reasonable time. A happy medium is the only solution to oxidation.

Oil Must Be Thin

Viscosity of core oil is of considerable importance. Core oil must be thin enough to mix readily and easily with sand and also spread thoroughly through the sand, otherwise the core will show hard and soft spots and cause troubles from core washes where the core is soft, and scabs where the core is too hard for the metal to lie against it.

Another vital requisite of core oil is that it be made of materials that will give off the minimum of smoke, fumes and gas, both in the core room and in the foundry. It is needless to say that there must be nothing injurious to health. Core oil has a rather hard *row to hoe* in that it is expected to be perfect and yet it or any other oil binder cannot be perfect at its best. One foundryman describing core oils states the requirements of a good core oil well as follows:

The maximum strength with a minimum of oil and a maximum of venting qualities is the object to be achieved. Again, from the foundry standpoint, a core must stand up under handling; furthermore, if it is to remain in the mold for any considerable period of time it is essential that it does not collect moisture. Neither must it soften or wash, yet, after the setting of the metal the core must crumble in order that it may be removed easily from the casting.

Core oils today are on a much different plane than they were years ago. It still may be within the memory of a few while stale beer served as a binder. Later came molasses, rosin and then core oils. The advent of the automobile more than anything else has built the core oil business, and just as the automobile business has been developed one step after another through keen competition, so has the core oil business progressed in standardization of products, perfection of requirement, and knowledge of raw materials. In line with the high state of efficiency among foundrymen today the manufacturer of core oil maintains careful and scientific control over both his incoming and outgoing materials so that qualities and standards may be maintained. Well equipped experimental and chemical laboratories are maintained for this purpose.

Practical Test Different

Core oils may be tested both chemically in the laboratory to determine what ingredients are used and in what proportions, and in a practical way in a foundry to determine their binding strength, workability, etc. However, testing core oils in a practical way is not an easy but in reality a difficult and arduous task. No matter how careful the test is conducted inaccuracies are bound to creep in, which seriously affect the results, especially where small amounts of sand and oil are used like in a proportion of 60 or 80 parts sand to 1 part oil. It is important that all tests be made in dry sand, that most careful attention be given to every step to safeguard against inaccuracies in quantities of oil, sand, moisture, etc. Comparative tests of oils should always be made at the same time and under the same conditions, and the cores placed in the same location and position in the oven and removed at the same time. The human element should be eliminated as much as possible in making the cores, and especially in ramming, as most unintentional discrepancies creep in accidentally. In a paper read before the New England Foundrymen's association the subject of moisture in sand as related to the binding strength of core oil was well expounded by R. F. Harrington, metallurgist of the Hunt-Spiller Mfg. Corp., Boston, which states:

Assuming uniform grain size and character in all tests, the moisture content, in my opinion, is of prime importance. No other varying element will so effect the accuracy of results obtained, in so far as character of core is concerned, as measured by breaking load. This is because wet sand means less volume of sand on a dry basis. In other words, dry sand packs closer in a given container than does wet sand.

We can illustrate the effect of moisture on volume by taking a 1000-cubic centimeter graduate of dry sand, moistening this with 100 cubic centimeters of water, or 10 per cent by volume. This gives a new volume of 1350 cubic centi-

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

CONTRACTION OF LIGHT ALUMINUM ALLOYS

(Continued from Data Sheet No. 500)

Effect of Zinc—Zinc reduces the contraction of aluminum, but its effect is not quite so pronounced as that of copper. However, since alloys containing up to 33 per cent zinc are suitable for some castings, commercial aluminum-zinc alloys may be employed which have less contraction than commercial aluminum-copper alloys containing up to 14 per cent copper. The following table gives some comparative figures for the contraction of zinc-containing aluminum alloys.

Linear contraction of some zinc-containing aluminum alloys; mean contraction when poured at 700 to 800 degrees Cent. in graphite molds.

Alloy Number	Nominal Composition	Linear Contraction Patternmaker's Inch per foot	Scale	Per cent
1	100 Al	0.198	1/60	1.65
14	90:10 Al-Zn	0.164	1/72	1.37
15	80:20 Al-Zn	0.145	1/82	1.21
16	67:33 Al-Zn	0.114	1/104	0.95
3	92:8 Al-Cu	0.161	1/74	1.35
30	90:2:8 Al-Cu-Zn	0.168	1/70	1.40
31	90:8:2 Al-Cu-Zn	0.155	1/77	1.29
32	85:3:12 Al-Cu-Zn	0.151	1/78	1.26
33	77:3:20 Al-Cu-Zn	0.139	1/85	1.16

Effect of Additions of 2 Per Cent of Various Metals on the Contraction of 92:8 Aluminum-Copper Alloys—The first of the two following tables shows the comparative linear contraction of four alloys of the 92:8 Al-X type, and the second table gives data for the comparative contraction of a number of alloys of the 90:8:2 Al-Cu-X type, when poured in chill molds, which may be found useful

(Continued on Data Sheet No. 502)

CONTRACTION OF LIGHT ALUMINUM ALLOYS

(Continued from Data Sheet No. 501)

for ready reference. When added to aluminum in the amount of 8 per cent, the metals are to be listed as follows in the order of their effect upon the contraction: (1) magnesium; (2) copper; (3) tin, and (4) nickel, where the first mentioned has the greatest effect in lowering the contraction. Similarly, when 2 per cent of different metals is added as a substitute for aluminum in the 92:8 aluminum-copper alloy, giving rise to ternary alloys of the 90:8:2 Al-Cu-X type, the metals are to be listed as follows in the order of their effect upon the contraction: (1) magnesium, (2) silicon, (3) nickel, (4) tin, (5) zinc, (6) iron, and (7) manganese, where the first mentioned has the greatest effect in lowering the contraction.

Comparative linear contraction of various binary alloys of the 92:8 Al-X type; mean contraction when poured at 700 to 800 degrees Cent. in graphite molds.

Alloy Number	Nominal Composition	Linear Contraction Patternmaker's Inch per foot	Scale	Per cent
3	92:8 Al-Cu	0.161	1/74	1.34
8	92:8 Al-Mg	0.138	1/86	1.15
10	92:8 Al-Ni	0.170	1/69	1.42
13	92:8 Al-Sn	0.166	1/71	1.38

Comparative linear contraction of various ternary alloys of the 90:8:2 Al-Cu-X type; mean contraction when poured at 700 to 800 degrees Cent. in graphite molds.

Alloy Number	Nominal Composition	Linear Contraction Patternmaker's Inch per foot	Scale	Per cent
3	92:8 Al-Cu	0.161	1/74	1.34
17	90:8:2 Al-Cu-Fe	0.155	1/77	1.29
20	90:8:2 Al-Cu-Mg	0.130	1/92	1.08
22	90:8:2 Al-Cu-Mn	0.168	1/70	1.40
24	90:8:2 Al-Cu-Ni	0.150	1/79	1.25
26	90:8:2 Al-Cu-Si	0.140	1/84	1.17
27	90:8:2 Al-Cu-Sn	0.151	1/78	1.26
31	90:8:2 Al-Cu-Zn	0.155	1/77	1.29

(Continued on Data Sheet No. 503)

EUGENE ADAMS, President
HERBERT ADAMS, Secretary.

CABLE ADDRESS
"ADAMS DUBUQUE"
LIEBERS STANDARD CODE.

ESTABLISHED 1883

THE ADAMS COMPANY

DUBUQUE, IOWA, U.S.A. May 29, 1923.

The Foundry,

Cleveland, Ohio.

Gentlemen:

Replying to your letter of May 23rd, would state that we have advertised our products in the pages of THE FOUNDRY for many years, and have found it to be a very effective advertising medium.

The prime requisite in conducting a sales campaign is to have reliable products, preferably products which possess greater than ordinary quality or which help the user to better his product or to secure greater production. This requirement is adhered to in the building of our molding machines and flask equipment.

The next step is to let the trade know about it. We do this in the columns of THE FOUNDRY, and attribute much of our success to the splendid publicity we have received in this manner.

THE FOUNDRY plays an important part in our idea of a successful sales campaign.

Very truly yours,

THE ADAMS COMPANY,

By Eugene Adams
President.

EA*FH

meters or an increase of 35 per cent. This increased volume varies with different sands. The figure of 35 per cent is obtained on local Wareham sand. Thus it is not difficult to see the marked effect of different moisture contents on the strength of cores.

An example will illustrate this. If on a dry basis a ratio of 40 parts sand to 1 of oil produced a core of proper strength, then the amount of oil on a wet sand basis could be reduced so as to use only 74 per cent as much oil. With the same amount of oil the core used in connection with the wet sand would break at a load equivalent to 35 per cent increase over the core of dry sand. Twelve cores, 1 inch square, broken on supports 6 inches apart were made using equal volumes of dry sand and of wet sand in the ratio of 40 to 1. Those cores in which the oil was applied on the dry sand basis averaged 24 pounds transverse load, and those made from the wet sand mixture averaged 33 pounds. Thus it is seen that we have in this practical test an increased breaking load of 33.4 per cent. These tests have a direct bearing upon the results obtained in the core room.

Try Melting Briquetted Brass Turnings

BY F. L. WOLF

AS the Ohio Brass Co. operates its own machine shop, its foundry has a continuous influx of brass borings and turnings to be remelted. Anyone with experience along this line knows that it is expensive to handle and melt these chips, and this question of expense confronted us when the idea of a briquetting machine was directed to our attention. The theory of this machine was excellent. By some adaptation of the hydraulic press we could compress our borings and turnings into briquettes which could be used practically the same as brass ingots. Theoretically this would greatly facilitate handling and melting. In addition, a tremendous amount of money could be saved. We decided to buy one of these machines, but our experience gained from the use of this machine was discouraging. A survey of the following data will indicate whether the results obtained were satisfactory.

After experimenting with a briquetting machine for several months, we found no economy in melting. We found it rather more convenient to carry briquettes up to the furnace than to carry loose chips but the breakage of briquettes in the furnace was considerable. The data in the accompanying table were obtained from ten specific heats with the use of briquettes and without the use of briquettes. All handling and furnace conditions were practically the same.

No difference was noted in the physical properties of the alloy melted nor in the appearance of the castings upon inspection.

Our experiments were carried out with a briquetting press purchased from the General Briquetting Co., a manufacturer making such a press as a regular line of product. The press consisted of a hydraulic cylinder and end block which is connected by means of two side rods. It was provided with a 4-inch diameter mold, 9 inches in length; stroke of ram, 24 inches; diameter of hydraulic piston, 10½ inches; retrieve ram, 4-inch diameter; and a working pressure 3000 to 3500 pounds per square inch.

The metal was melted in a Schwarz furnace, the average charge being about 540 pounds. In the first test 150 pounds of borings were used per heat, the remainder of charge consisting of scrap and prime metal. It took about 50 minutes to get the metal up to the proper pouring temperature and no difference in time of melting was noticed whether the borings were charged loose or in briquetts. In the second test 225 pounds of borings were charged per heat and it then took about 65 minutes to bring the metal up to the pouring temperature. Again there was no time saved by the use of briquettes.

To determine the net melting loss, and after pouring ladles, which hold about 100 pounds of metal were weighed before and after being filled with molten metal. The difference was added to the total pounds of metal poured from the heat. The skimmings and slag were run through a concentrating plant and the metal recovered. The melting loss, whether we charged loose borings or briquettes, was practically the same.

If the convenience in carrying briquettes up to the furnace was the only item to be considered, the briquetting machine would now be in use in our foundry instead of being discarded. Unfortunately that is not the case. After storage for any considerable length of time the briquettes would develop cracks and distintegrate. After charging into the furnace considerable breakage of briquettes occurred. This was no doubt due to the air pockets in the briquettes expanding, the internal pressure thus set up disintegrating them. According to the manufacturers of the briquetting machine, this was not supposed to occur, but even by following their instructions implicitly, we could not prevent the troubles.

Considerable experimenting has been carried on in our foundry to determine the effect of charging various combinations of prime metal, scrap (gates, sprues, etc.) and chips. We have taken this matter up more in detail in another article.* We have found that any reasonable combinations of prime metal, scrap and chips can be used providing there are not too many detrimental impurities present such as sulphur, iron, etc., and that proper foundry conditions have been maintained. In our foundry we have been obtaining consistently good results by using any number of combinations. We aim to use up our scrap just as fast as it is received in the brass foundry and we make up our mixes accordingly. Briquetting the borings made no difference in the physical properties as compared to using loose borings, as we maintained the proper furnace conditions while melting and poured at the proper temperature.

Data of Heats Using Turnings

	No. heats	Total metal pounds	Pounds poured	Pounds loss	Pct. loss	Metal recovered: Skim and slag	Metal recovered: from slag	Metal recovered: Total recovered	Net loss	Pct. loss
Loose borings	5	2608.5	2426.5	182	7	142	84	2510.5	98	3.75
Briquettes	5	2603.5	2419.5	184	7	148	88	2507.5	96	3.7
Loose borings	5	2610	2450	156	6	180	62	2516	94	3.5
Briquettes	5	2610	2429	181	6.9	193	78	2507	103	3.9

Will Operate Brass Shop

Cox Brothers, general brassworkers, Albany, N. Y., have purchased the premises at 406 Pearl street, formerly occupied by J. Smith, brassfounder, and shortly will begin casting operations in brass and aluminum on a specialty basis.

Paper presented at the convention of the American Foundrymen's association, held in Cleveland, April 28 to May 3. The author, F. L. Wolf, is technical superintendent, the Ohio Brass Co., Mansfield, O.

*Some Information on the Proper Melting and Pouring of Brass and Bronze, by F. L. Wolf and W. Romanoff, A. F. A., *Transactions*, 1923.

Equip Small Steel Foundry

Experience Gained from Operating Under Adverse Conditions Utilized in Building New Shop Arranged to Reduce Handling to a Minimum—Alloy and Carbon Steel Melted in Electric Furnace

HE WHO works under a handicap even though he sees no hope of overcoming the obstacles at hand spends hours dreaming of how he would like to change conditions were it in his power. The progressive manufacturer who finds himself unfavorably situated devotes thought to his problems and when he sees an opportunity to solve them correctly, he is careful to make the best of the move through the experience he has had in working under difficulty. Many foundries which have been started years ago under conditions then prevailing find themselves handicapped today through inadequate facilities. When such an organization finds itself able to correct the situation it has a wealth of experience to draw upon which a newly formed company lacks. It has its customers and knows fairly accurately the extent of the business it will be able to secure in the near future. It is familiar with the class of castings it will be called upon to make and has a general idea of the quantity which will be carried on an order. Thus it can decide quite accurately the number and kinds of molding machines to install, the core making appurtenances, the melting, handling, cleaning and capacity required. Also, it will know about what percentage of its product can be shipped advantageously by railroad and what portion by truck. With these factors known many of the questions involved in locating and planning a new foundry are answered.

The Crucible Steel Casting Co. had the advantages of an established practice as a guide when it decided to move from its cramped and poorly arranged quarters in the flats of Cleveland, the old manufacturing district along the banks of the Cuyahoga river which winds its way from the south to Lake Erie through the center of Cleveland under the big High Level bridge which joins the eastern and western sections of the city. It not only knew what would be demanded of the new plant, but it had a full appreciation of the importanee of the handling problem, as the old plant was poorly designed to secure the most efficient transportation of materials. Much thought was given to all natures of design and equipment and the firm feels after nearly a year's operation in the new plant that no major changes would be made if it were to be built a second time under similar conditions.

From the crowded district in the flats the plant was moved to a large tract of ground at the base of West Eighty-fourth street facing on Almira Ave., in the southwestern section of the city. George S. Rider Co., Cleveland, was employed to design the plant and in conjunction with the officials of the company evolved the present layout.

The main building 102 x 240 feet which is built of brick on steel frame construction with a large percentage of the walls of steel sash, faces north on Almira Ave., and looks into West Eighty-fourth street. At the side of the main building is a long concrete building which is used as a service building. This is clearly indicated in the plan of the buildings shown in Fig. 1 which also shows how the spur from the C. C. C. & St. L. railroad comes into the grounds. This is more clearly evident in Fig. 5 which is a view between the two buildings looking north toward Eighty-fourth street. At the north end of the concrete utility building, a concrete platform is built under which is located a tank capable of holding five cars of fuel oil which is pumped through a system

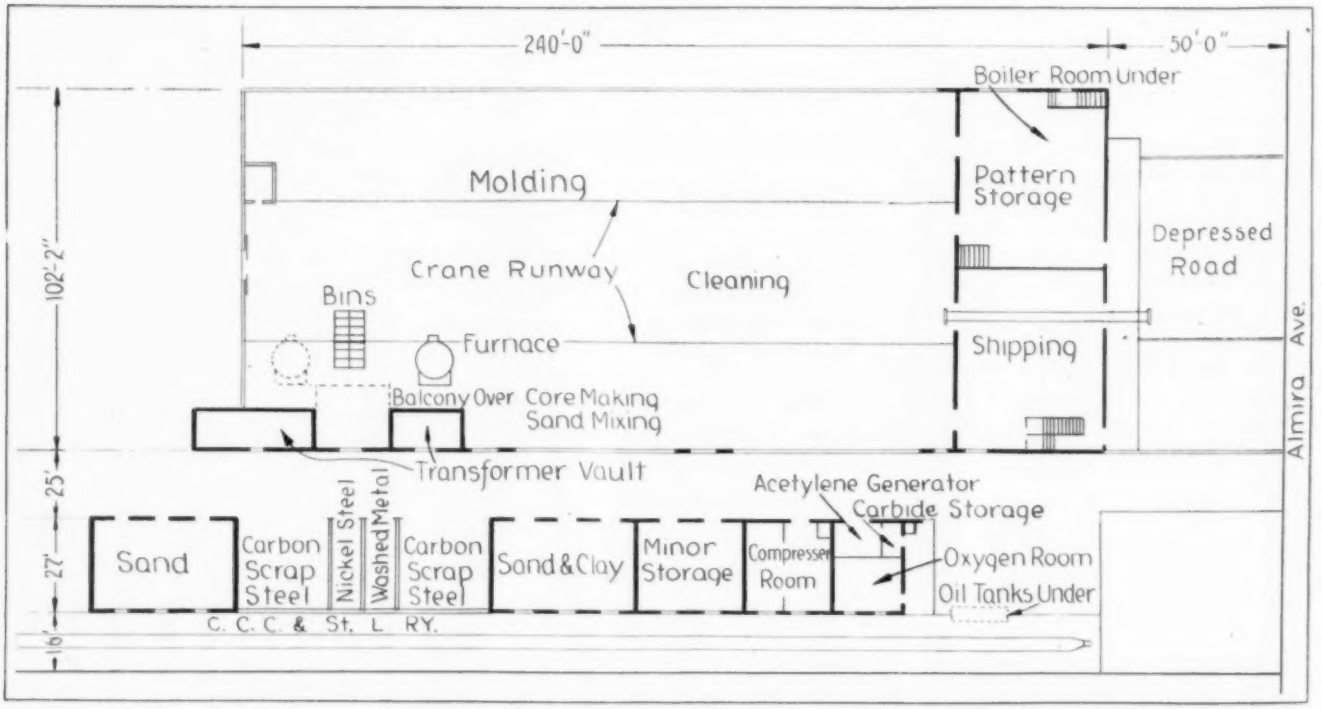
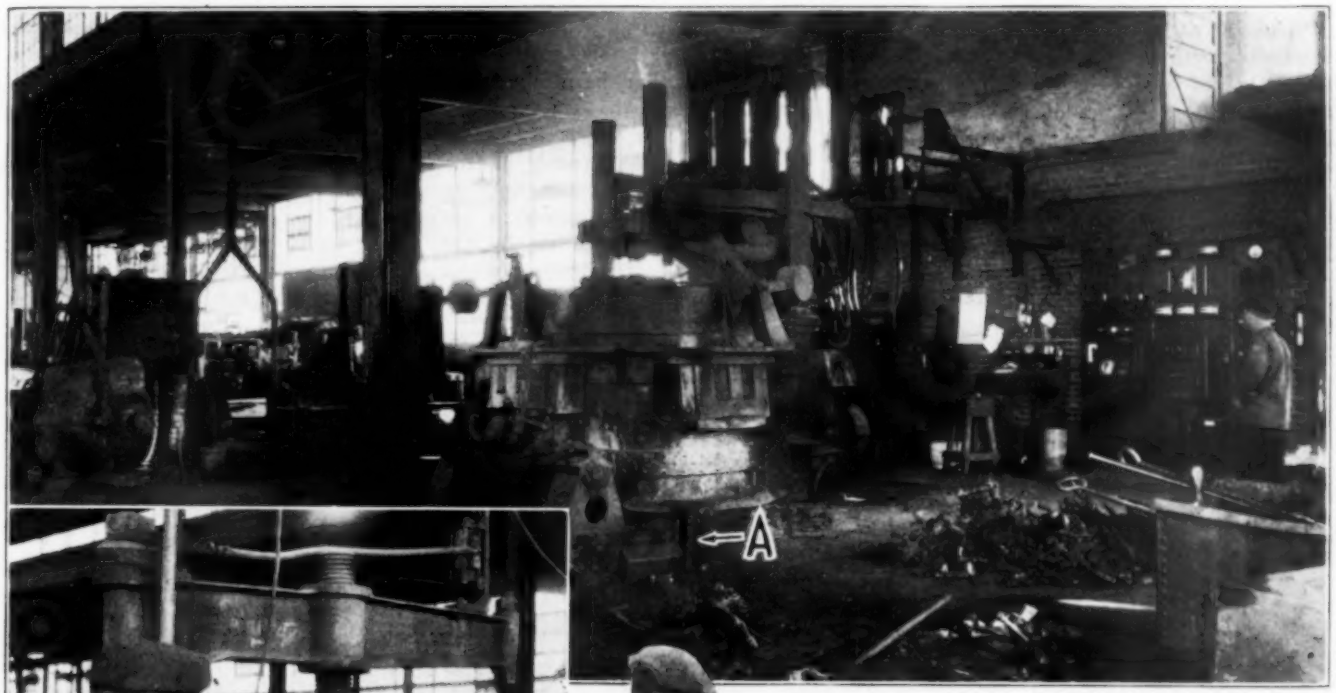


FIG. 1—PLAN OF THE MAIN FOUNDRY AND UTILITY BUILDING—NOTE HOW THE STOCK IS MOVED FROM THE STORAGE BINS TO THE FURNACE, THEN TO THE MOLDS, FROM WHICH POINT THE CASTINGS ARE TAKEN TO THE CLEANING DEPARTMENT AND FINALLY TO THE SHIPPING DEPARTMENT WITHOUT RETRACING ANY STEPS



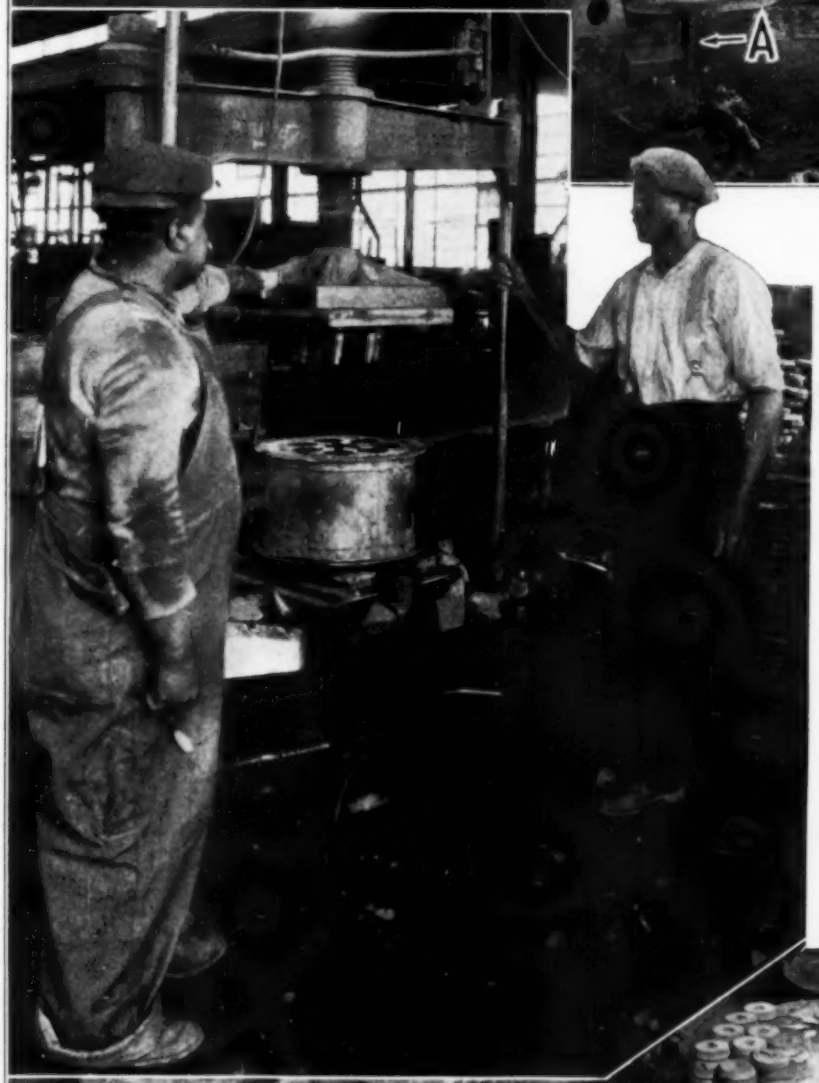


FIG. 2—THE ELECTRIC FURNACE IS LOCATED IN ONE CORNER OF THE SHOP. FIG. 3—PATTERNS ARE DRAWN BY A MAGNETIC CLUTCH. FIG. 4—COVER CORES ARE PLACED OVER EACH INDIVIDUAL MOLD AND THEN THE ENTIRE DRAG IS COVERED WITH A GREEN SAND COPE

of pipes from which outlets are advantageously located throughout the building. Oxygen also is piped through the building from a room at the north end of the utility building. The oxygen is secured in tanks a number of which are connected to the line at a time.

The acetylene generator room may be noted in Fig. 1, next to the oxygen room, with the storage for the carbide in a small room adjacent. This room is fireproof, as the partitions, like the walls of the building are built of concrete. The acetylene generator, which was built by the Oxweld Acetylene Co., Chicago, is located over a sewer so that the water is carried off rapidly when drained from the generator. A compressor, built by the Ingersoll-Rand Co., New York, supplies air a 85 to 90 pounds pressure. This is located in a room next to the oxygen and acetylene rooms. This arrangement is convenient for piping the air, oxygen and acetylene as well as the oil through a conduit to the main building. Steam for heating the utility building is piped through the same conduit from the boiler room which is located under the shipping department in the main building. Steam is used only to heat the buildings as all power is secured from electricity furnished by the local public service corporation which also supplies current for the electric melting furnace in the foundry building.

The remainder of the utility building is used for storage except a portion of the room which is utilized as a carpenter shop, for repairing flasks and other miscellaneous work. Sand and clay for immediate use are stored in bins in the compartment next to the minor storage room. The sand is unloaded from railroad cars which are spotted at the side of doors opening into the storage bins, and is wheeled to the core department immediately opposite in the main building. Two bins are provided for carbon steel scrap and two smaller bins for nickel steel scrap and for washed metal, the high carbon iron with low silicon, sulphur, and phosphorus used to recarburize the metal. The latter takes the place of pig iron in furnishing carbon to the steel in the electric furnace. These bins are not covered and the scrap is unloaded from the railroad cars directly to the bins. A second sand storage building is located beyond the scrap bins.

As may be noted, the utility building is arranged to serve the different departments in the main building, the sand being stored opposite to the sand mixing department and the scrap being unloaded in close proximity to the melting furnace. A view of the scrap bins opposite the door in the main building, which lead to the furnace, is shown in the

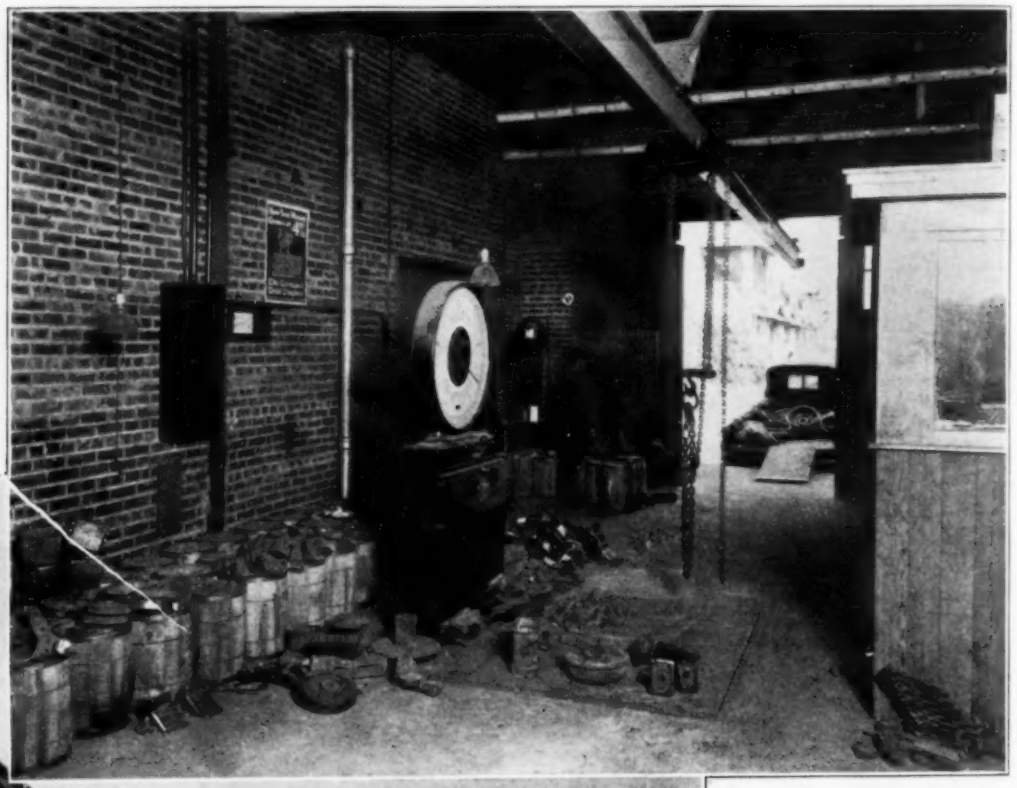


FIG. 5—VIEW BETWEEN THE MAIN SHOP AND THE UTILITY BUILDING

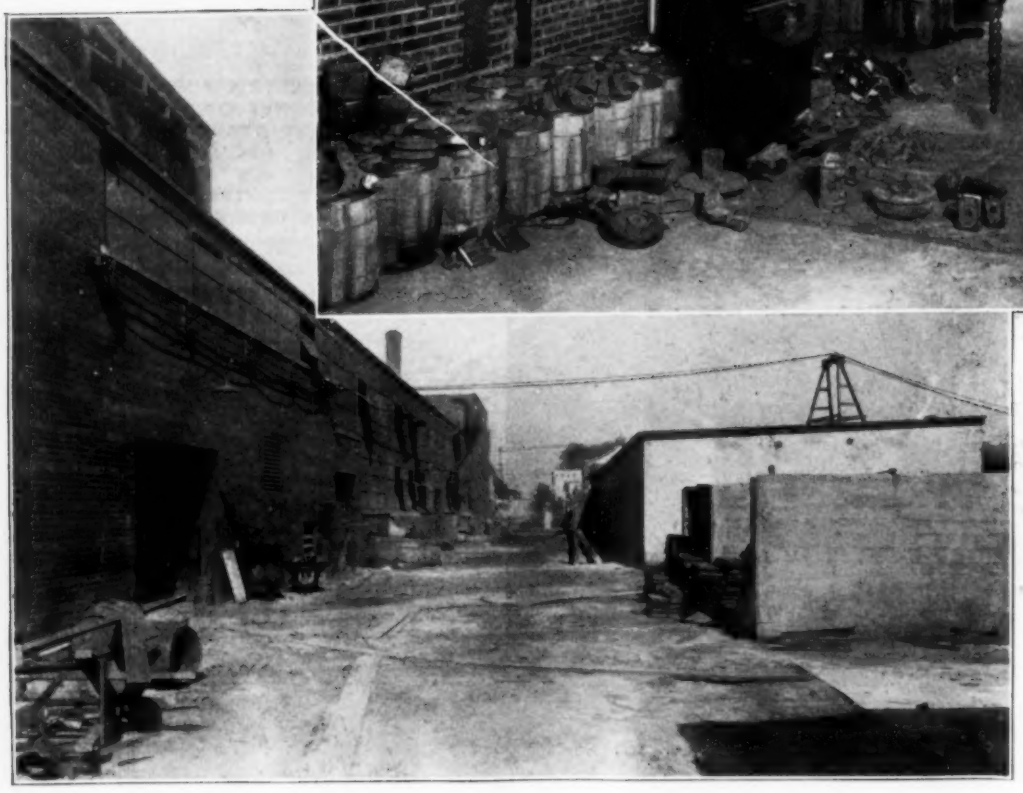


FIG. 6—A MONORAIL CARRIES THE CASTINGS TO TRUCKS IN A DEPRESSED ROADWAY

foreground, Fig. 5. This also shows the high tension wires entering the main building at the transformer vault, and the raised roof over the furnace. Fig 2 shows the furnace which is of the heroult type, built by the American Bridge Co., New York. This illustration shows the central monitor roof. The roof above the furnace is raised to permit the installation of a 1-ton traveling crane to serve the furnace. This crane, which is operated from the floor, raises the electrodes to the mezzanine floor which is built between the two transformer vaults with a platform extending out under the crane runway. A spare furnace roof also is stored on the mezzanine floor. The crane serves to carry the roof and the electrodes to the furnace. As indicated in Fig. 1 a second transformer vault has been built and space has been left for a second furnace. When this is installed the shop will be extended to the south, the south wall being built of corrugated sheet steel so that it may be removed easily when the time comes.

FIG. 8—TWO CASTINGS LAID TOGETHER FOR A TESTPIECE MOLD

The present furnace was moved from the old shop where the company had become thoroughly familiar with its operation. It is equipped with an electrode control system furnished by the General Electric Co., Schenectady, N. Y. The rear end of the furnace is raised for pouring and the front is held in position, turning on the trunnions shown under the spout. With this arrangement the ladle need not be moved while the furnace is being tilted to pour the steel, as the spout remains in the same relative position during the operation. The furnace is acid lined and from 10 to 12 charges of 2 tons are poured every 24 hours when the shop is operating at capacity, although the other departments are operated only single turn.

Charges are weighed on a platform scale near the furnace, as the metal is brought from the stock pile. Heats of plain carbon steel are followed by heats of alloy steel and the latter again by heats of plain carbon steel according to the molds ready to receive the steel. The company makes alloy steels of nickel, nickel-chromium, nickel-chromium-vanadium, and chromium-vanadium. The block at *A*, Fig. 2 is used to break the test piece cast to determine the state of the metal in the furnace. The test piece is cast on a steel block on which two catsings with a lug on the end are arranged to form a long narrow mold. The arrangement of the cast-

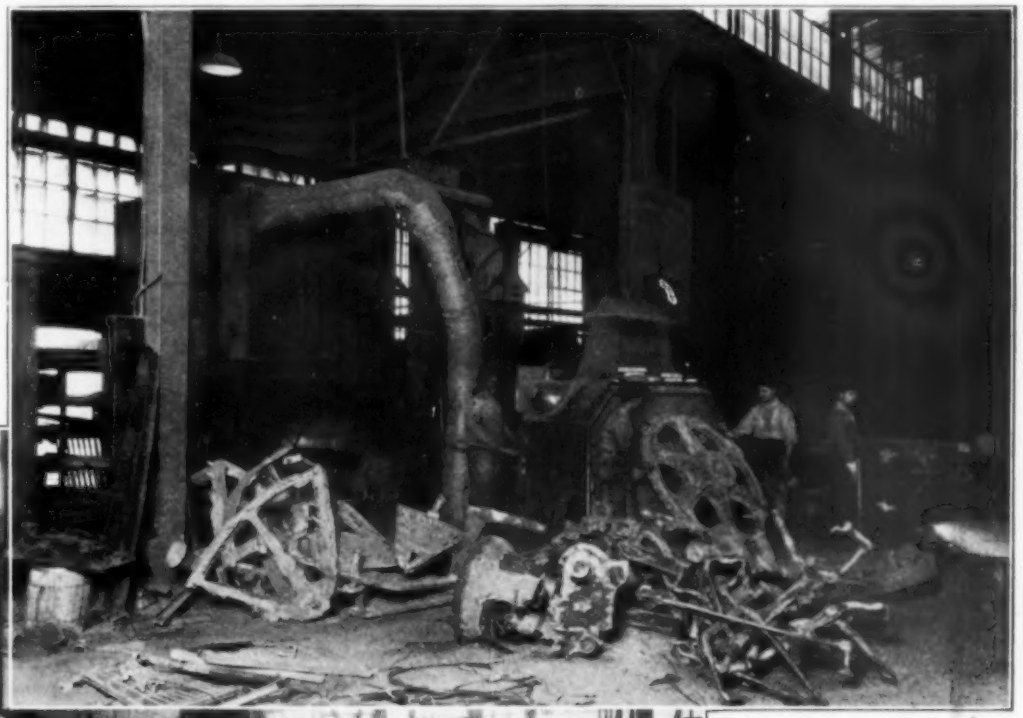


FIG. 7—CASTINGS ARE BROUGHT IN DUMP BUCKETS TO THE FLOOR NEAR THE CLEANING DEPARTMENT

FIG. 9—SAND-BLAST EQUIPMENT IS IN A SIDE BAY OPPOSITE TO THE GRINDING AND CHIPPING DEPARTMENT

ings to form a mold is shown in Fig. 8. As soon as the metal has set, the two castings are pulled apart and the test piece is picked up by a pair of tongues to be quenched and broken. To break it the test piece is placed in one of the holes in the upright of the casting shown at *A*, Fig. 2, and the section which protrudes is broken off with a sledge hammer.

Ladles are heated by oil burners. The large ladle is placed on its side on a casting having four pedestals to prevent the ladle from rolling, and a burner is inserted. A brick wall which the open end of the ladle faces reflects the heat back into the ladle. A ladle in position is shown at the extreme left in Fig. 2. A heater for the hand ladles is located at the right of the heater for the large ladle. The former consists of two long brick walls parallel to each other. The space between is covered with brick except at intervals where openings are left for the flame from the burners to emerge and heat the ladles placed over them.

FIG. 10—A TRANSFER CAR IS USED SO A CAR MAY BE CHARGED IN THE ANNEALING OVEN AS SOON AS ONE IS TAKEN OUT

Moves In Direct Line

The melting furnace has been placed at the end of the building so that materials can be moved in a line until finished without retracing any steps. This is indicated by a study of the layout of the plant as indicated by Fig. 1. The molding department is located opposite to the melting furnace and the core room. Directly opposite to the core room, a mold drying oven has been placed and dry sand molds are made in proximity to it. After the castings are shaken out of the sand they are carried to the north end of the shop and dumped in the center between the grinding department on the one side and the annealing and sand-blasting department on the other. The finished castings then are taken to the shipping room at the extreme end of the shop.

Details of Practice

Now that an understanding of the main course of the castings is explained it will be well to take up the different departments in detail. Sand is mixed in a muller type mixer built by the National Engineering Co., Chicago. Core sand is delivered direct to the benches of the coremakers which are close to the mixer. The core department is equipped with an oil-fired, drawer-type oven built by the F. J. Ryan Co., Philadelphia. The large rack type oil-fired oven for drying molds was built by the same firm. The loaded racks are handled by a lift truck supplied by the Barrett-Cravens Co., Chicago.

Floor work is molded in the center bay of the shop where the services of a 5-ton traveling crane are available. This crane was built by the Euclid Crane & Hoist Co., Euclid, O. The lighter work is made on benches along the west side of the shop and on four molding machines. One of the molding machines is of the jolt squeeze type built by the Osborn Mfg. Co., Cleveland, while the three others are of the jolt squeeze type with magnetic pattern draw. The latter were built by William H. Nichols, Inc., Brooklyn. One of these machines is shown in Fig. 3 with the pattern drawn and held by the head of the machine. This can be done as the bottom of the pattern board is fitted with a steel plate and when the head of the machine is magnetized by throwing a switch which closes an electric circuit it attracts the steel plate. To draw the pattern the head of the machine is placed on the pattern board and the switch is thrown to magnetize it. Then when the head of the machine is raised by compressed air it carries the board with it.

The mold in this case is of interest as it shows a novel method for producing hollow cylindrical castings. As indicated in Fig. 4, seven castings are made in a mold. The drag is made on the magnetic draw machine as described. A cover core is set on each individual mold for a casting and a center core is dropped through the cover core and pressed into the core print in the lower section of the drag. The cover core not only serves to locate and hold the center core, but has an indentation at the one side for a gate. Steel is poured through a center gate in the large sand slab placed on top of the mold as shown on the molds at the left, Fig. 4. The metal falls into a pocket in the drag and is distributed from this to the various castings. The sand slab is rammed on a bench, placed on the mold, and the frame removed.

Fig. 9 is a general view of the chipping, tumbling, and grinding department, the sand-blast equipment and annealing oven being in the opposite side bay. This illustration shows how the castings are dumped in the center bay, one of the buckets being shown in the foreground. A workman with an acetylene torch is shown back of the dump bucket cutting off gates and risers. This operation also may be seen at the right in Fig. 7 which shows the sand-blast table with the dust arrester behind it. A large wheel is in position ready to be turned with the table to be sand blasted. This equipment was supplied by the Pangborn Corp., Hagerstown, Md.

Transfer Car Serves Oven

The annealing oven, built by the F. J. Ryan Co., is directly north of the sand blast. This oven, which is oil-fired, is of the car type. A transfer car is arranged as shown in Fig. 10 so that a car may be brought out of the oven, pulled off the transfer car and another car be brought in front of the oven to be pulled in without delay. A wire cable attached to the end of the car passes through a pulley block fastened to the floor at some distance from the oven so that when the crane hook is attached to the cable the car is

pulled forward by raising the crane hook. To get the car into the furnace a second cable attached at the same place on the car is extended back to a pulley near the oven door before it is passed through the front pulley. Then a tension on the cable draws the car back to the pulley near the oven door. A double recording pyrometer furnished by the Wilson-Maeulen Co., New York, is equipped with two thermocouples, one of which is placed in the center at each side of the oven.

The cleaning department, Fig. 9, is equipped with two tumbling barrels furnished by the W. W. Sly Mfg. Co., Cleveland. Six double grinders are located against the side wall and the chipping bench and three swing grinders are arranged along the north wall. In the same illustration may be noted the door leading into the shipping department. An I-beam extends into the foundry, through the shipping department and partly over the depressed road where trucks are parked for loading. The castings brought to the I-beam in buckets can be carried readily to the scale and from it to trucks which are backed down an incline to the door or the shipping department so that the level of the truck body is at the same height as the floor of the shipping department.

The scale which was furnished by the Toledo Scale Co., Toledo, O., is opposite to a wooden booth as is indicated in Fig. 6. This illustration shows the I-beam with the chain fall and a truck on which castings have been loaded.

Four Order Copies

The shipping clerk, sitting in the booth has the production orders to which he can refer in weighing a shipment. He then makes out the bill of lading in quadruplicate. Two copies of this are sent with the driver, the one to be left at the place of delivery and the other to be receipted and brought back to the foundry. One copy is mailed to the customer and the fourth copy is kept by the shipping clerk. While most of the castings are shipped by truck, it occasionally is necessary to ship carload lots by freight in which case the car to be loaded is spotted at the end of the railroad track.

The section in which the shipping room is located is cut off from the remainder of the foundry by a brick wall and has two floors instead of one. The lower floor is divided by a brick wall into the shipping department and the pattern storage. The pattern storage is made as fireproof as possible by having steel racks and fire doors. A steel stairway leads from the pattern storage to the offices on the second floor. This is accessible only from the shop. The main entrance is located at the northeast corner of the building and another steel stairway leads from this to the offices. A clear view may be had from the offices over the entire foundry. This is indicated by the windows in the upper right corner of Fig. 9, on the other side of which are the offices. Adjacent to the office on the second floor is a dressing room with showers, wash basins and toilets. This is reached by the workmen through the pattern storage department. The office wash room also is located on the second floor. A room has been provided on this floor for a laboratory and is fitted with running water, gas and drains, but so far the company has found it satisfactory to have its analytical work done at a Cleveland laboratory equipped for commercial work.

Dynamite Employed for Breaking Scrap

IN A RECENT issue of a magazine published by a company engaged in the manufacture of explosives, H. H. Barnes, Denver, describes how he removed an 8-foot pulley, 14½-inch face, from a shaft with the aid of dynamite. The wheel formed part of a general assembly and the problem presented was to remove it while leaving everything else intact. An attempt first was made to break it with sledge hammers, but after two men had pounded on it for some time without making any impression, a decision was formed to employ dynamite.

The sequence of operations was as follows: Holes ¾ inch in diameter were drilled through the spokes close to the hub, and a row of ¾-inch holes were drilled along each side of the hub. Also one hole nearly 6 inches deep was drilled in the center on one side of the hub, the entire drilling job requiring the time of two men for about six hours.

With the wheel in a position so that a certain spoke was vertical a whole stick of ⅞-inch by 8-inch 40 per cent gelatin was exploded in the groove at the top center of the wheel, directly over the spoke, with the result that the rim was split sideways and cracked loose from the end of the spoke. This operation was repeated around the wheel, using whole and half sticks as pieces were loosened, until the entire rim was broken into pieces which one man could handle easily. Care was used to break pieces from opposite sides in sequence so that the mechanical balance of the wheel was maintained to a degree that permitted turning it without too great effort. With the rim removed the holes in the spokes were then filled completely full of powder, a cartridge being broken for the purpose and the loose powder rammed into the holes with a small stick. No wadding or capping of any kind was used and the fused cap was inserted directly into a small hole punched into the powder, only one hole at a time being loaded. This astonishingly small quantity of explosive was found ample to crack the spoke so that a light tap with a sledge served to break it off completely.

After removing the last of the spokes, which weighed nearly 100 pounds each, two of the four holes on each side of the hub were similarly rammed full of loose powder and fired, the explosion of the last shots cracking the hub but not throwing any small pieces whatever. The one deep hole in the center of the hub was then loaded, requiring only about one-third of a stick of powder. The explosion split the hub cleanly through the center and dropped it in two pieces on the floor almost directly under the shaft, leaving the shaft clean and absolutely unmarred or even scratched.

A total of about 30 sticks, or 8½ pounds, of 40 per cent gelatin was used. Approximately 50 caps and 40 feet of fuse were required, making a total cost of material for the job less than $4.

Will Start Steel Foundry in Cincinnati

The Sawbrook Steel Castings Co., was incorporated at Columbus, O., Nov. 2, with $300,000 capital. The company which will manufacture electric steel castings will locate its plant in Cincinnati. Among the incorporators are: C. E. Sawtelle, vice president and Elmer S. Sawtelle, general manager of the Tool Steel Gear & Pinion Co., Cincinnati. The incorporators met Nov. 6, to elect officers and select a site for manufacturing purposes.

The Prime Mfg. Co., Milwaukee, is considering the construction of a brass foundry.

Bill Pours 2-Ton Job with ½-Ton Ladle

BY PAT DWYER

OF ALL the possible and impossible styles of clothing worn by human beings the wide world over. I am sure that Burns—not Wullie, ye ken, but Bobbie—had fashionable modern riding suits in mind when he coined that famous phrase:

Oh, wad some power the gifties gie us
Ta see oorsel's as ithers see us!

The male of the species tricked out in his shiny boots and little monkey trousers presents a sufficiently comical spectacle, but the female! Man, man, the sight is fair peetifu'.

Occasionally Bill and I drive through one of the city parks and if the time happens to coincide with the fashionable riding hour we are sure to see many of these wonderful creations on the bridle paths that traverse the park and in some instances parallel the boulevard for considerable distances. The reins and riding crop are held rigidly in one hand at just the correct elevation and the rider's body rises and falls perpendicularly and mathematically exactly 40 times to the minute while the horse dashes madly along at an estimated speed of at least 5 miles per hour.

Highly scientific gentleman—and others not so highly qualified, but who for want of something better to do, take up a study of the subject—advance interesting and occasionally startling theories to account for mental reactions. Perhaps they are right. I do not know. I suppose there is a reason for everything, but I never have lost any sleep or appetite worrying over things beyond my control. My thoughts—and yours—come and go apparently of their own volition so what is the use of trying to figure out the combination responsible for the manner in which they appear, change and disappear. The same thought and the same set of circumstances will not cause the same mental reaction at all times. I have watched these park riders on many occasions without any particular interest, principally because this is a free country and I realize that if a man or woman feels the urge to trick himself or herself out in fantastic garments, he or she is perfectly within his or her rights in going the limit to gratify that desire. However, the last time one of these painfully correct groups of riders crossed our line of vision my mind flew off at a tangent to newspaper accounts I recently had read of a revival of the pony express that formed a fitting climax to a series of events commemorating the days of '49.

I intimated to Bill that the 40 riders in 50-mile relays who made the 2000 long, weary miles that lie between St. Joseph on the muddy Missouri and San Francisco on the far Pacific, probably did not show collectively as much daylight between themselves and their wiry mounts in the entire journey as one of the ornamental riders in the course of a park constitutional.

Daylight or dark, morning or night, under the blazing noonday sun, the shy, quiet stars or the glowing radiance of the round red harvest moon, the message of greeting was passed from hand to hand. Mounted and ready, poised for instant flight, a man waited at each relay station prepared to snatch the message from the rider who came reeling in on a dripping horse, foam flecked on bit and bridle and heaving chest. A curt greeting, a hasty transfer and the second rider was away in a cloud of dust or a shower of sparks struck from his horse's hoofs depending on whether the rendevous had been held on the prairies of Kansas or the flinty surface of one of the great mountain states.

When a boy I invariably got a thrill out of the old war poem describing Sheridan's famous ride to Winchester, 20 miles away. Even yet if the truth must be told, I cannot read the poem without taking a long breath before the stirring lines:

"Under his spurning hoofs the road
Like an arrowy Alpine river flowed."

and then I experience a wild impulse to wave my cap in circles around my head and yell, Attaboy!

The picture of the great black horse, bearing the indomitable rider with his military cloak flying in the wind, tearing along at a screeching clip for all the world like a fire-breathing gigantic bat out of the bottomless pit, is as vivid in my mind as if I had stood by the roadside, pop eyed, as I have no doubt many a young lad stood in the grim old fighting days when the war cloud hung low over the Virginias and the Carolinas.

"Well," said Bill, "I'll tell you. The recent revival of the pony express even for one trip was an inspiring undertaking and I certainly would have enjoyed the sight of a few laps of the race against time, the most inexorable of all pacemakers. However, you don't want to forget, young-feller-me-lad, that the race was carried out under circumstances entirely different from those which characterized the trip in the old days, when a rider's chance of winning through with a whole skin depended fully as much upon his skill with a pair of long barreled Colts as it did on the speed and stamina of his faithful

ORIGIN OF THE EXPRESSION "THE GREAT DIVIDE"

little mustang. Also, me boy, you will search for many a long day in ancient or modern history before you will find anything to equal the record hung up by Buffalo Bill, prince of all pony riders when on one memorable occasion he carried the mails and remained in the saddle over a stretch of 343 miles. Marauding parties of Indians in war paint and feathers and equally dangerous road agents had wiped out every relay station in the hostile territory. The mails had to go through and—in spite of hell and high water—Bill delivered the goods. Wow! There were real men in those days. Men with the red blood of adventure dancing under their hairy chests. Men who carried the American frontier beyond the Rockies. Traveling conditions in the Far West have undergone a wonderful change for the better since the days of the pony express and still more when compared with conditions existing some 70 years ago when the hardy Argonauts pursued the setting sun toward the golden land of California.

"Days of '49 practically only exist as a tradition so far as the great bulk of the population is concerned, but they have not been buried so deeply in the dim and distant past that they cannot be recalled vividly by a few actual survivors. There are not wanting today men and women who in their childhood or early youth accompanied their parents to the fabled land where gold nuggets were reputed to be scattered over the landscape with prodigal profusion and where tradition existed to the effect that loose and shining particles from the mother lode poured down to the sea in the shifting sands of the Sacramento.

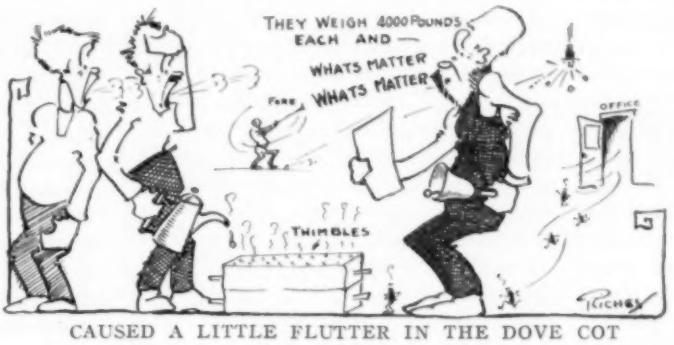
"Days of privation and suffering and long lonely nights spent in fear and trembling lest the wily Apaches or the cruel and murderous Comanches should sweep down in a whirlwind of driving arrows and attack under cover of darkness, implanted the incidents of the journey on their tender minds in a manner that will endure with them to their graves. The canvas covered wagon that served as a habitation, a storehouse, a refuge and all that stood between them and annihilation, crept slowly across the wilderness extending from the Mississippi to the promised land. Day by day and month by month the long overland trail unrolled before their weary eyes in the morning and only was shortened by a pitifully few miles when the wagons were drawn up in a ring around the camp fire at night.

"Many of the eastern emigrants who finally arrived at their destination never returned east of the Rockies. Others, in later years were enabled to take advantage of the excellent railroad transportation provided and in comfort and luxury traversed the continent in a lesser number of days than the original westward journey consumed in months.

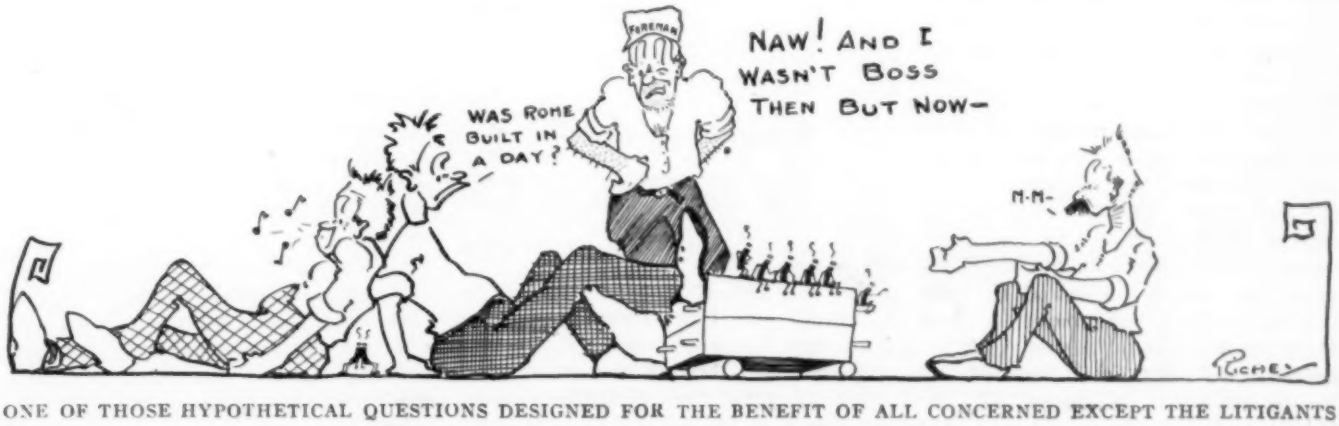
"In these modern days the jolting, swaying, squeaking prairie schooner is replaced by the luxuriously appointed Pullman and the gaunt and emaciated, plodding horses or oxen are replaced by a steel giant that never tires. Across the sunny land of California, up and ever upward it climbs with many a spiral over the coast range, the Sierras, the elevated plateau, the continental divide and then with whistling jets of steam from her cocks, grinding brakes and occasional snarl of reversed drivers, the big mountain engine with its string of heavy steel coaches comes pounding down the long grade that terminates in the rolling prairie.

"By day and night, totally oblivious of flood, fire or the avalanche of snow that sometimes rolls down the sides of the Rockies or the Spanish Sierras, the long, heavy trains roll on the shining ribbons of steel extending from coast to coast. The roar of the exhausts from thousands of iron lungs is heard in every state in the Union and the two long and two short screaming blasts of a siren wake the echoes in a million hamlets and at grade crossings to warn inhabitant, traveler or casual wayfarer to stand away from the path of a messenger bearing express treasure, hurrying passengers and the transcontinental mail of the United States of America. Man is an adaptable kind of a creature, if he were not he would have perished long since from the face of the earth. Evidence of his adaptability every place is apparent, even in the foundry. I worked at one time in a little shop equipped with a cupola made from an old boiler shell and lined down to about 25 inches. We made light miscellaneous jobbing castings with an occasional piece weighing a few hundred pounds. We had one 1000-pound ladle, that was used once or twice a year, but the usual 3000 or 4000-pound heat was poured with a 300-pound bull ladle, one that carried 200 pounds, and a few hand ladles. Under these conditions you can imagine the excitement that arose when the old man announced that he had secured the contract for a number of 4000-pound weights for a balance on a coal loading pier.

"We had no crane, and a 4000-pound lump of iron is no toy to handle. The problem was solved by making two molds for each casting and pouring part of each casting on alternate days. A 1-ton casting was poured on the first day. This casting colloquially known as a *dutchman* was placed on suitable supports inside the second mold on the following day and the second ton of iron was poured into the mold until the first casting was completely surrounded. Both



CAUSED A LITTLE FLUTTER IN THE DOVE COT



ONE OF THOSE HYPOTHETICAL QUESTIONS DESIGNED FOR THE BENEFIT OF ALL CONCERNED EXCEPT THE LITIGANTS

castings were made in open sand molds in wood drags reinforced by cast iron clamps.

"The size and weight of a casting is only relative and is in direct proportion to the size of the shop and the equipment provided. At this time this 4000-pound casting loomed larger than many a 50-ton job I have seen since. Making the mold presented no particular difficulty but believe me, filling it with iron was some job. The molds were made close to and directly in front of the cupola and we employed a block and tackle suspended from one of the beams to handle the 1000-pound ladle. On the first occasion the ladle was set up on horses and filled by dumping the contents of the 300-pound ladle into it several times. We had to rig the block and tackle on the following day to remove the casting and thereafter the same hoist was employed to lift the ladle. The beam in its natural condition would not support the load. We had to erect props, one on either side of the sling to which the block was attached.

"The 1000-pound ladle was filled first and dragged along the floor into position near the runner basin. A short piece of chain between the ladle bail and the block and also the charcoal covering on the iron protected the hemp rope in the hoist. The two bull ladles then were filled and taken to the opposite end of the mold. They were held for a few minutes to allow additional iron to accumulate in the well of the cupola. The 300-pound ladle was poured first and then taken back to the cupola where it was filled and taken back to the mold before the other two ladles had ceased pouring. The 200-pound ladle was handled in a similar manner and served to bring the iron in the mold up to the required height.

"The drag in which the mold was made, was constructed in two sections and designed in a manner that provided a 12-inch thickness of sand under and all around the pattern. Less than 12 inches would have served under the pattern, but 12 inches was little enough protection between the hot casting and the sides and ends of the flask. The first section of the flask was leveled on the floor and filled with cinders to a depth of about 6 inches. The remainder of the flask was filled with sand and rammed firmly. Not hard, but just firm. The surface was vented down to the cinders, scraped off flush and slicked and then the pattern, which simply was an open frame, was placed in position after which the second section of the flask was adjusted and rammed full of sand. A runner basin was built on each end and then the pattern was removed. The face of the mold was covered with dry blacking rubbed on the surface by hand.

"The finished casting was lifted by a block and tackle at each end and transferred to a number of wood rollers resting on a pair of long planks on the gangway and then pinched along to the door. A low hung two-horse truck, known down in that part of the country as a *sloven*, was backed up to the door and the casting was pulled up a gentle incline until it rested over the back axle.

"If I had the job to do over again or perhaps I should say if a similar problem presented itself in a shop where I had the say-so, I would bed the pattern in the floor and adopt one of two methods to pour it. In the first I should dry the mold so that it should serve as a natural reservoir and fill it by successive taps from the cupola. In the second method I should construct a reservoir close by. I would fill the reservoir by successive taps and keep it covered with charcoal until I had accumulated a sufficient amount to fill the mold. Then the iron could be tapped directly into the mold in a continual stream. In that manner I would get clear of all the extra help with the necessary incidental confusion and danger."

"Did you ever hear the story," I said, "of the foreman who told the young man he was not working fast enough?"

"I don't know," said Bill suspiciously. "What is it? I have heard a good many. In fact I have played in a few of these sketches myself. Sometimes on the pitching end and sometimes on the receiving end of the battery. However, if it will ease your mind, or if you can remember it correctly, spill it. I'll bite."

"This big, domineering foreman," I said, "objected to the leisurely manner in which one of his faithful henchmen was toying with his rammer. He told him so. To be exact, he said 'Hey, you, get a hump on. You will have to hit the ball harder than that if you expect to stick around this joint.' The young man retaliated, I regret to say impudently that Rome was not built in a day. 'I know it wasn't,' chortled our hero, 'but I wasn't bossing that job.' "

Book Review

Causes and Prevention of Corrosion; by Alan A. Pollitt; cloth; 230 pages. 7 x 9 inches; published by D. Van Nostrand Co., New York and furnished by THE FOUNDRY, Cleveland, for $6.50 net.

During recent years considerable information has been published concerning corrosion, but as this material is scattered it has been difficult for those interested in the subject to secure the information conveniently. No previous work deals in a comprehensive manner with the practical aspect of the problem, its causes and the methods available for protecting metals from it. Therefore, in this volume it had been the author's endeavor to present as completely and concisely as possible the more interest and practically useful information on the various phases of the subject. The work is not claimed to be thoroughly complete because of the incompleteness of the knowledge in many directions, but it will serve as a convenient reference book. The author is associated with the Manchester College of Technology, Manchester, England.

A theoretical treatment of the subject of corrosion necessarily is included since knowledge is essential to the successful diagnosis and prevention or alleviation of corrosion troubles. This composes Part I of the book. Part II deals with the causes of corrosion and Part III, the prevention of corrosion. A number of illustrations and tables are used in the text. Part I consists of three chapters, namely, introduction, theory of corrosion and forms of corrosion.

Part II is made up of the following chapters: Function of oxygen, influence of the electrolyte on the corrosion of iron; influence on corrosion of factors inherent in the metal; water—its sources, characteristics and impurities; behavior of impurities in waters used for steam raising; and corrosion of condenser tubes. The following chapter headings make up Part III: Control of impurities and manufacture; oxide and non-metallic protective coatings; metallic protective coatings; paints and allied coatings; and feed water treatment.

Cost Control for Foundries; by Frank Everitt and Johnson Heywood, 226 pages. Cloth, 5¼ x 9; published by McGraw-Hill Book Co., New York, and sold by THE FOUNDRY, Cleveland; price $3.00.

No doubt every foundry has some kind of a cost system, no matter how crude. The only question is how far to extend the details of the system. This book lays the groundwork for the acceptance of the system it propounds by telling the foundryman in the first chapter what a cost system can do for him. Then after explaining the fundamentals of costs, a rather elaborate system, requiring 72 forms, is described in detail so that the reader may understand each step. The book offers a definite system for cost accounting and gives the details by which this plan may be adapted to the large foundry.

Simplifies Molding Practice

A Combination of Dry Sand Core and Improved Clamping Arrangement Reduced Losses to a Gratifying Extent When Introduced in Connection With the Manufacture of Automobile Flywheels

BY J. H. EASTHAM

AUTOMOBILE flywheel castings, owing to their simple design and to the rigid specifications which usually accompany an order are particularly well adapted to the cover core system of molding in which a dry sand core takes the place of the usual green sand cope. The manner in which the method is practiced at the foundry of the American Car & Foundry Co., Detroit is shown in the accompanying illustrations. In addition to the reduction in defective castings effected by this method, the initial cost of providing the necessary equipment is insignificant in comparison to the cost of providing what is considered standard equipment in the shape of copes and drags, machined on the joints and provided with pins and corresponding pin holes. After the flasks have been fitted up for making flywheels, the bar extensions in the cope, designed to support the projecting body of sand, automatically prevent the flasks from being used for any other purpose than the one for which they were intended. The drag frames hereafter described may be employed for molding any casting within their boundary limits. Other parts of the equipment may be adapted to various jobs with little, and in some cases, with no adjustment.

A typical disk flywheel casting 15½ inches diameter and weighing approximately 60 pounds in the rough is shown in Fig. 1. The casting must be clean, smooth and solid because in the machine shop it is finished all over and 120 spur teeth are cut on the periphery.

According to the terms of the contract the foundryman was obliged to provide all necessary equipment and no restrictions were placed on any method he might choose to produce the castings. The customer stipulated perfect castings at a certain price per pound and there his interest ceased. Under former conditions where the molds were made in the usual manner on a pair of jolt ram, stripping plate machines the loss from various causes was considered too heavy. The usual factors were responsible, including cope drops, due to improperly tempered sand heaps, insufficient jolting and molds clamped carelessly. All three potential causes of trouble were eliminated by the

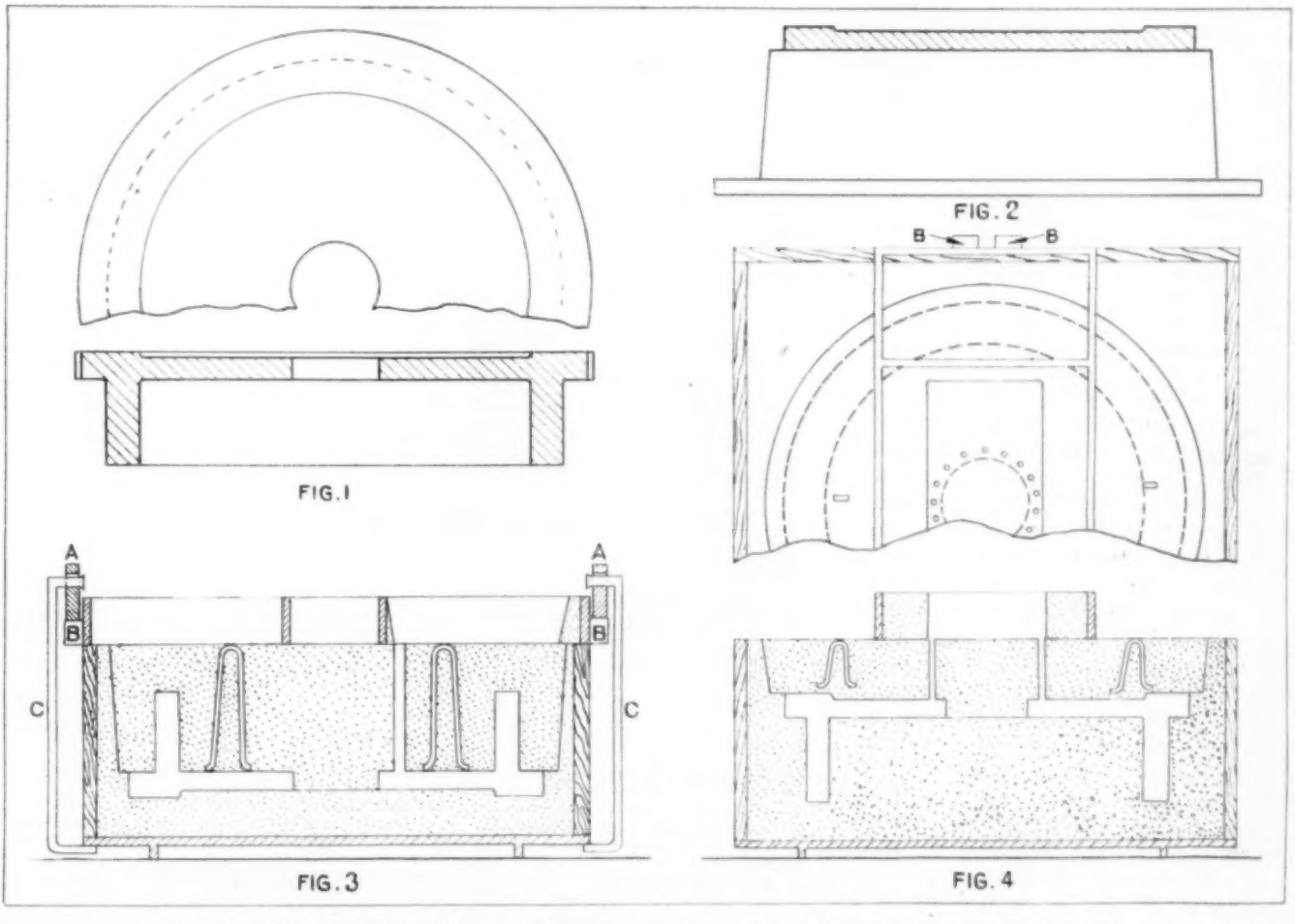


FIG. 1—PLAN AND SECTION OF AUTOMOBILE FLYWHEEL CASTING. FIG. 2—DRAG MOLD PATTERN AND CORE PRINT MOUNTED ON MACHINE PLATE. FIG. 3—ASSEMBLED MOLD WITH CLAMPS IN PLACE. FIG. 4—PLAN AND SECTIONAL VIEW OF MOLD MADE IN THE OPPOSITE POSITION TO THAT SHOWN IN FIG. 3. THE IRON IS POURED THROUGH A RING OF PENCIL GATES.

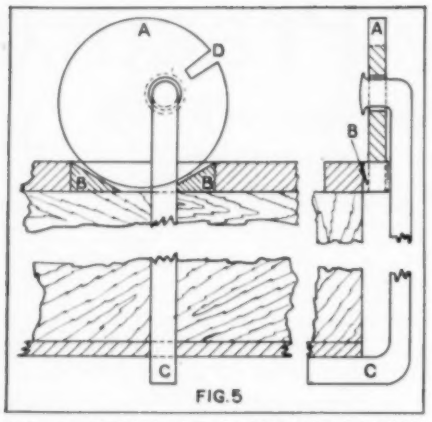


FIG. 5—DETAIL OF CLAMPING DEVICE

substitution of a dry sand core for the usual green sand cope.

The drag side of the pattern was attached to a tapered core print 3 inches larger in diameter than the pattern disk and extending to a height that would provide 2 inches of sand over the heavy flange formerly molded in the cope. This feature is illustrated in Fig. 2 where the assembled pattern and core print are shown in place on the machine plate ready for the drag. Square wood frames strongly nailed and braced served as drags in making the molds. The frames were wide enough to provide a 1-inch thickness of sand between the core print and the wall at the narrowest points on the four sides. They also were deep enough to provide 3 inches of sand between the bottom board and the casting. The drags were the only flask equipment required.

Before the cover cores were delivered to the floor in the morning, two men jolted a number of drags and set them out on the floor. Afterward one man set the cover cores, made up the runners and clamped binder grids on the top to bind the molds together. He also assisted the first man in lifting the drags from the machine to the floor. An assembled mold showing the binder grid, single runner and clamps in position is illustrated in Fig. 3. The same method for making the mold with the plain side of the pattern on the upper side is shown in plan and cross section in Fig. 4. In the second instance the mold is poured through a ring of pencil gates and in both variations of the same method, the cover core is provided with an extension in the center to form the central opening in the web of the casting.

The binder grids and clamps employed on this and a variety of other work were designed by H. Rypsan, pattern shop superintendent. The grid is provided with two lugs at either end and rests on the drag frame as shown at *BB* Figs. 3, 4 and 5. Detail of the lugs and clamp is shown in Fig. 5.

An iron disk 3 inches diameter, 5/8 inch thick is provided with a 7/8 inch hole a little off center. The upper toe of a 3/4-inch clamp is riveted through the hole in such a manner that it is free to swing but not to come out. The lower toe is turned in the usual manner to secure a firm grip on the bottom board. In practice the grid is laid on top of the core that serves for a cope. The outer ends of the grid rest on the frame of the drag and in the event that the grid does not touch the core a pinch of sand or a small wedge is employed to make contact. The disk *A* Fig. 5 is placed between the tapered faces of the lugs *BB*, the lower toe of the clamp is pushed under the bottom board, an old file or other piece of flat steel is inserted in the gap *D* to pull the disk up a few degrees. The cam construction tightens the clamp and holds it in place. A slight blow or a kick releases the clamp after the mold is poured. The binder grid also serves as a runner box as shown in the plan Fig. 4. The runner is made up in the center pocket in this instance, but it also may be made up in any other pocket in the event that any particular casting required a runner in any other position.

As a result of adopting the foregoing method the casting loss was reduced to 2 per cent; the cost of equipment amounted to approximately half that where whole flasks were employed.

Form Classifies Castings

SETTING correct prices for castings for the average jobbing foundry is a complicated task. The foundry without a strict cost system must rely on the judgment of the cost clerk, which often is little better than guess work. Even where costs have been determined accurately

Ideal Standardized Casting Prices

Confidential Quotation No. _____ Cleveland, O. _____ 192__

Gentlemen:

We propose to make castings on your orders, as follows.

Castings from Standard Gates	Red Brass Per Lb.	Std'd Bronze Per Lb.	Gun Metal Per Lb.	Std'd Alum. Per Lb.		
Base Price, no cores, run of 50 molds or less						
Base Price with cores, run of 50 molds or less						

A Standard Gate is one producing at least 3 lbs. and up to 3½ lbs. of casting per mold, requiring not larger than a 12"x18"x8" two piece snap flask. Work that is larger or that requires unusual work in molding or finishing will be individually figured for each specific case.

Gates Lighter Than Standard	No Core	With Core
Producing per mold: Not under 2½ up to 3 lbs., add to Base Price		c. lb.
" " 2¼ " " 2½ " " " " "		c. lb.
" " 2 " " 2¼ " " " " "		c. lb.
" " 1⅞ " " 2 " " " " "		c. lb.
" " 1½ " " 1⅞ " " " " "		c. lb.
" " 1¼ " " 1½ " " " " "		c. lb.
" " 1 " " 1¼ " " " " "		c. lb.

Anything lighter to be specially figured

Gates Heavier Than Standard	No Core	With Core
Producing per mold: Not under 3½ up to 4 lbs., deduct from Base Pr.		c. lb.
" " 4 " " 4½ " " " " "		c. lb.
" " 4½ " " 5 " " " " "		c. lb.
" " 5 " " 6 " " " " "		c. lb.
" " 6 " " 7 " " " " "		c. lb.

Anything heavier to be specially figured.

	Brass & Bronze	Aluminum
If Aluminum Match Plate is furnished instead of Open Gate, deduct	5%	3%
If over 50, up to 100 Molds ordered made at one time, deduct	5%	3%
If over 100, up to 250 Molds ordered made at one time, deduct	6%	4%
If over 250, up to 500 Molds ordered made at one time, deduct	7%	5%
If over 500 Molds ordered made at one time, deduct	8%	6%

Castings from Standard Single Loose Patterns	Red Brass	Std'd Bronze	Gun Metal	Std'd Alum.		
Base Price, no cores						
Base Price, with cores						

A Standard Single Loose Pattern is one producing not less than 5 and up to 6 lbs. of casting to the pattern.

Loose Patterns Lighter Than Standard	No Core	With Core
Producing per pattern: Not under 4 up to 5 lbs., add to Base Price		c. lb.
" " 3 " " 4 " " " " "		c. lb.
" " 2½ " " 3 " " " " "		c. lb.
" " 2 " " 2½ " " " " "		c. lb.
" " 1½ " " 2 " " " " "		c. lb.
" " 1 " " 1½ " " " " "		c. lb.

Loose Patterns Heavier Than Standard	No Core	With Core
Producing per pattern: Not under 6 up to 7 lbs., deduct from Base Pr.		c. lb.
" " 7 " " 8 " " " " "		c. lb.
" " 8 " " 9 " " " " "		c. lb.

Anything heavier or lighter to be specially figured. Patterns requiring intricate molding to be specially figured.

If specific price is desired on any special casting, send samples with advice as to size and makeup of gate, or send gate from which we will make trial mold, and we will state exact price.

This quotation for reasonably prompt acceptance and is not binding on us until you send us written acceptance.

After such acceptance it will be binding on us for _____ days for such specified orders as you send us in that period. After such period we may change the prices to conform to market changes in the prices of copper, tin, aluminum or labor, but no such change will go into effect until we have sent you a new written quotation.

No responsibility attaches to us for delays caused by strikes, fires, public calamities or similar causes beyond our control.

Respectfully submitted,
THE IDEAL BRONZE CO.,
Per _____

MANY FACTORS ENTER INTO THE PRICE OF A CASTING AND THESE ARE BETTER ESTIMATED WHEN PROPERLY CLASSIFIED

it is difficult for the salesman to estimate on a job from figures based on the cost of certain castings. To assist him a number of foundries have devised classification sheets by which the salesman can classify the casting to be made from it and rules laid down by the cost department can determine closely the proper selling price for the castings.

One of these classification sheets used by the Ideal Bronze Co., Cleveland, is shown in the accompanying illustration. The first classification is castings from standard gates for which not more than fifty molds are required on an order. These are divided according to whether the castings require cores or not. Then the price per pound is quoted according to the metal of which the casting is to be made. By a standard gate is meant one which produces at least 3 and up to 3½ pounds of castings per mold, in a certain sized flask. Gates producing less weight of castings than a standard gate are divided into seven classes according to the weight of metal in the castings on a gate. Gates heavier than the standard gate are divided into five classifications. The smaller gates include those which produce as little as 1 pound of castings to a gate, and the heavier gates produce as high as 7 pounds of castings. Below the lower figure and above the higher figure each job must be estimated specially. Percentages are given for deductions in case an aluminum match plate is furnished instead of an open gate; also when over 50 up to 100; over 100 up to 50; over 250 up to 500; and over 500 molds are ordered made at one time.

A somewhat similar classification is made for castings from standard single loose patterns. However, in this case no classification is made according to the number of molds required on an order. The weight of the casting from a standard loose pattern is limited to not less than 5 and up to 6 pounds. Castings weighing less than the allowance for castings from a standard loose pattern are graded into six classes extending to castings weighing 1 pound each. Castings weighing above 6 pounds are divided into three classes covering castings from 6 to 9 pounds in weight. These classifications like those of castings from standard gates also are subdivided into castings requiring and those which do not require cores.

The estimate sheet was prepared by E. V. Coulston, proprietor of the Ideal Bronze Co.

Adam Jarr Jr., 32 years old, son of Adam Karr, president of the Karr Range Co. of Belleville, Ill., died unexpectedly in California on Sept. 20. Mr. Karr was a traveling salesman for his father's company, and departed for the West two months ago apparently in the best of health.

Patterns Should Be More Carefully Made

BY RICHARD BATES

An article by M. E. Duggan which appeared on page 576, July issue of THE FOUNDRY comments on the construction of a pattern. Mr. Duggan refers to the fact that many pattern makers design bearing cores to be hung in the cope and then suggests a method by which the molder may use a plain stock core by filing babbitting rings at each end. The concluding lines of the article indicate that he is describing a method to be used in an emergency or on a rush job, but even so, I do not approve of leaving anything for the molder to do except make the mold and pour it. Pattern should be made and carefully checked to the drawing. For a pattern of the description under discussion, the brackets *G, E, H* should be fastened together and dowelled to the frame. A core print should be provided at each side of the pattern to support the journal core ends instead of a print on the top necessitating hanging the core in the cope. If the strips or lugs *A, B, C, D* are not ½-inch high they can be attached solidly to the face of the pattern. It is to be regretted that close co-operation does not always exist between the pattern shop and foundry and lends weight to the contention that both should be under the one superintendent. The foundry business is one of production and any new work coming in, other than standard, should receive the careful consideration of the pattern shop foreman, the foundry foreman and the superintendent. Consultations of this kind show results.

According to the department of commerce census for 1919, 345,460,096 pounds of brass and bronze castings were produced in that year.

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Variables Limit Definite Statements

UNDOUBTEDLY, operations would be much simpler for the foundryman if he could find more tables giving the exact influence of the different elements on cast iron, and stating definitely what pressure and volume of air he should put through his cupola. Some one has kindly furnished him with a formula giving the volume of air—30,000 cubic feet of air per ton of iron melted. But of what practical benefit is this rule? If the foundryman is operating under average conditions it may work satisfactorily. However, few foundries work under average conditions. Some have extremely small cupolas while others have the largest sizes. Again, some melt with a ratio of 11 pounds of iron to 1 pound of coke, while others melt with a ratio as low as 5 to 1. Another variable enters into the problem in the form of the composition of the coke charged. The combustible in coke is carbon and the percentage of this varies. Therefore, with one coke more air would be required than with another. Would it not be more logical to gage the amount of air required by the amount of coke consumed?

However, even here a definite volume of air per pound of coke burned cannot be specified. Two variables enter into the equation, namely the percentage of carbon in the coke, and the products of combustion. The former can be determined readily by the usual method of drying the coke, heating a stated length of time at a red heat to drive off the volatile matter, and finally igniting until all the carbon is consumed, weighing between each operation. Now with the percentage of carbon and volatile matter determined it is easy to calculate the amount of oxygen required to convert the carbon into carbon dioxide, CO_2. Therefore, it would not be difficult to determine exactly how much air to blow through the cupola for each pound of coke charged, if it were not for the facts that an excess of air must be delivered to the tuyeres and that much of the carbon dioxide is reduced by the carbon of the coke to carbon monoxide, CO, which requires only half the amount of oxygen per pound of coke as does the formation of carbon dioxide. After the foundryman has definite information as to the percentage of carbon and volatile matter in his coke and composition of the gases escaping from his cupola he can determine fairly closely the amount of air to blow through the tuyeres per pound of coke charged.

This is only one of the points which requires definite limitations when a formula is stated. Another is depth of chill that a certain iron containing a given amount of silicon will take. One table of chill depths in irons of different silicon contents was published some years ago by a prominent metallurgist, and recently another table of chill depths was published by an organization that is one of the highest authorities in the foundry industry. The two tables do not agree. As an example, the one table says that iron with 0.70 per cent silicon will give a ¾-inch chill, while the other says the chill will be ¼ inch. Both probably are right for certain iron poured under certain conditions, but the statements can not be of more than general interest to the foundryman. More qualifications with less definite statements would be better.

Trade Outlook in the Foundry Industry

RUNNING counter to expectation in many quarters, early November foundry operations have proved fairly satisfactory. Radiator shops are working practically to capacity, and furnace foundries closely approximate the former in their operations. However, stove foundry activities have slackened though not to the degree normally experienced at this time of the year. Automotive foundries making castings for the lighter and cheaper cars still are busy, but a few of them expect a marked decline during December. Practically all cylinder foundries are using the opportunity to revamp and replace equipment for the coming year, and extensions are planned. This applies to new and extensions to buildings and equipment.

Buy Metal Cautiously

Practically all foundries, with the possible exception of the larger pipe shops and sanitary ware plants, are buying their metal sparingly and only when needed. A falling market on both pig iron and scrap has induced gray iron, malleable and steel foundries to hold off, using their stocks so far as possible and buying in car load lots only for urgent demands. Similarly, brass foundries are not anticipating. Close buying governs, both in price and quantity. Little apprehension is felt on the subject of fuel during the winter months, as expressed by the orders for coke, coal and fuel oil. Confidence in the ability of the railroads to handle all requirements, is backed by the knowledge of large available stocks. On Sept. 1, the stocks of coal on hand were the largest since Jan. 1, 1919, with the single exception of the period in April, 1922, when a coal strike was imminent. Production of coal at the present rate exceeds consumption by four to five millions tons a month. Further, the output of coke for the first ten months is almost three times the production for the same period last year.

Prices of Raw Material for Foundry Use

CORRECTED TO NOV. 7

Iron		Scrap	
No. 2 Foundry, Valley	$24.00 to 25.00	Heavy melting steel, Valley	$15.00 to 15.25
No. 2 Southern, Birmingham	19.00 to 20.00	Heavy melting steel, Pitts.	15.50 to 16.00
No. 2 Foundry, Chicago	23.00 to 24.00	Heavy melting steel, Chicago	13.50 to 14.00
No. 2 Foundry, Philadelphia	23.76	Stove plate, Chicago	17.50 to 18.00
No. 2 Foundry, Buffalo	21.00 to 22.00	No. 1 cast, Chicago	20.50 to 21.00
Basic, valley	22.00 to 22.50	No. 1 cast, Philadelphia	19.00 to 20.00
Basic, Buffalo	21.50	No. 1 cast, Birmingham	19.00 to 20.00
Malleable, Chicago	24.00	No. 1 cast, Buffalo	19.50 to 20.50
Malleable, Buffalo	21.00 to 21.50	Car wheels, iron, Pittsburgh	16.00 to 16.50
Coke		Car wheels, iron, Chicago	17.50 to 18.00
Connellsville foundry, coke	5.00 to 5.75	Railroad malleable, Chicago	18.50 to 19.00
Wise county foundry, coke	6.00 to 6.50	Agricultural mal., Chicago	18.00 to 18.50
		Malleable, Buffalo	17.00 to 18.00

Railroads Will Buy

Purchases of railway equipment which passed through a period of quiet in the Fall have quickened. During the first week of November 68 locomotives were awarded by two railroads. Further, a heavy car inquiry is extant, totaling in excess of 80,000 cars. This inquiry is expected to develop into buying for early 1924 delivery. Railway machine shop requirements are expected to materialize before Jan. 1. An interesting development is the placing of contracts for malleable cast iron tie plates by an eastern line, which prefers the cast plate to the sheared rolled steel product, by reason of the rust resisting properties of malleable iron. Steel and malleable shops making railway sundries are active. According to the department of commerce, the production of malleable during September was 59.9 per cent of capacity. Orders booked were slightly under this figure, but October orders are expected to surpass those reported for September. The American Steel Foundries are running practically full, but a slackening is expected by the end of the year. Implement makers are buying rolled steel and placing castings contracts for the coming year.

Production Declines

The output of pig iron, according to statistics compiled by THE IRON TRADE REVIEW, showed a drop in October. The total reported was 3,152,246 tons in October compared with 3,117,526 tons for September, giving a gain in actual tonnage of 34,720 tons. However, the daily average production was at the rate of 101,685 tons or 2232 tons less per day in October than in September, when the average was 103,917 tons per day. The rate of production is the lowest shown since December, 1922. The daily average output has declined steadily for five consecutive months. Merchant iron production for the past month was 733,706 tons, a loss of 1048 tons when compared with the September total of 734,754 tons. The daily average output for October was 23,668 tons, a loss of 823 tons per day in comparison with the previous month's figure of 24,491 tons. Nine less stacks were in blast on the last day of October than on Sept. 30. Of the total number in blast, 75 were reported as making merchant iron, two having been blown in and six reduced to inactivity. According to the department of commerce, the total of pipe orders received by 12 establishments was 170,800 tons and of this amount 14,215 tons was to be shipped from stock. The pipe orders include those for September.

Nonferrous Operations

Brass foundry operations are spotty. In general, the plumbing goods shops are fairly active, but the automotive lines are slow. Price on nonferrous metals based on New York quotations in the DAILY METAL TRADE of Nov. 7 follow: Casting copper, 12.37½c; electrolytic copper, 12.62½c to 12.75c; Straits tin, 41.87½c; lead, 6.75c to 6.80c; antimony, 9.25c; nickel, 99.80 per cent, 32.00c; aluminum, No. 12 alloy, producers price 24.50c, and open market, 20.00c to 21.00c. Zinc is 6.35c to 6.40c, East St. Louis, Ill. The average prices for September follow:

(New York Quotations)

Casting Copper	Electro Copper	Lead	Tin Straits	Antimony	Aluminum 98-99	Zinc St. Louis
12.579	12.852	6.882	41.880	7.85	25.00	6.302

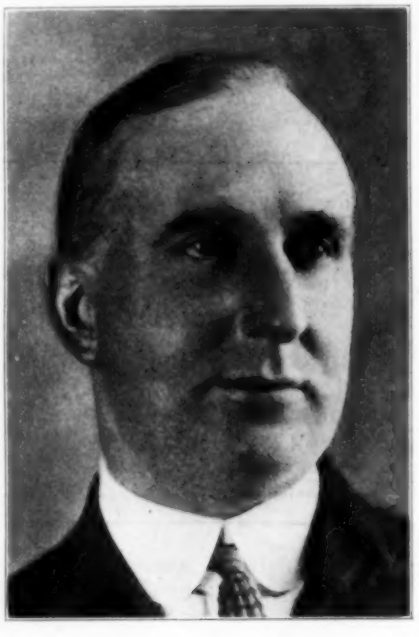
Comings and Goings of Foundrymen

CHARLES N. RING, recently has been made manager of the Allied Steel Castings Co., West Harvey, Ill. Mr. Ring started in the foundry business in 1900 with Schikle, Harris & Howard, E. St. Louis, Ill. working during his school vacations. In 1904 he was graduated from the University of Missouri, and following that period, he practiced law in St. Louis, until 1908, when he entered the chemical laboratories of the American Steel Foundries, E. St. Louis. During the time he was connected with the latter company, Mr. Ring became thoroughly conversant with the chemical and physical laboratory work and gained open hearth experience. In September, 1913, he was made chief chemist and metallurgist for the Alton Steel Foundry, Alton, Ill., leaving this company to become connected with the Illinois Steel Co., Gary, Ind. Later he returned to Alton as chief chemist and metallurgist for the Laclede Steel Co. plant in that city. In June, 1918, Mr. Ring joined the Ohio Steel Foundry as chief chemist and metallurgist, having charge of this work at the three plants in Bucyrus, Springfield and Lima, O., until his resignation Sept. 1, 1923 to accept the position which he now holds. Mr. Ring is a member of the joint sand research committee of the American Foundrymen's association and the National Research council and is chairman of the refractories committee of the former organization.

Arthur J. Tuscany, secretary and manager of the Ohio State Foundrymen's association addressed a joint meeting of the Newark Foundrymen's association and the Gray Iron Club of New York at Newark, N. J., Wednesday evening, Oct. 31. Mr. Tuscany outlined the work and ambitions of his organization with reference to the advancement of the foundry industry.

J. F. Newman, who for 12 years was purchasing agent of the Weirton Steel Co., Weirton, W. Va., has become president of the Lawrenceville Bronze Co., Pittsburgh, to succeed the late John F. Robertson. The Lawrenceville company manufactures copper and bronze castings, specializing in blast furnace tuyeres, coolers, bosh plates, valve seats and rolling mill bearings.

F. W. Hobbs, director of the Standard Brass Foundry Co., Benoni, South Africa, has returned to the Transvaal after spending several weeks in Europe, during which he attended the international foundrymen's congress in Paris. The company with which Mr. Hobbs is connected has made some of the largest bronze castings ever produced south of the equator. The Standard Brass Foundry Co. is contemplating the installation of a steel casting department. Mr. Hobbs, who is one of the leading foundrymen in South Africa, of which



CHARLES N. RING

he is a native, is a member of the Institute of British Foundrymen.

Cummings C. Chesney, general manager of the Pittsfield, Mass., works of the General Electric Co., observed his sixtieth birthday anniversary, Oct. 28 with a family gathering at his home. He has been a pioneer in many electrical improvements and two years ago was awarded the Edison medal for research work.

Change Portuguese Firm Title and Offices

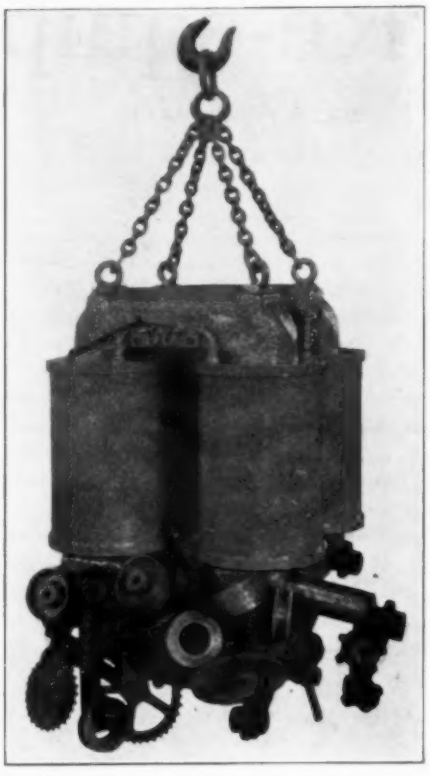
The name of E. Duarte Ferreira & Filhos, one of the leading Portuguese machinery manufacturing and importing firms, Tramagal, Portugal, has been altered to Duarte Ferreira & Filhos. The general offices together with practically all the records of this company were destroyed by fire in June. Since that time provisional offices have been built and the business is being conducted as usual. Duarte Ferriera & Filhos manufacture agricultural and other types of machinery and import machine tools, internal combustion engines, locomotives, etc., from United States, Great Britain and other countries.

Celebrates Its Fiftieth Anniversary

The Industrial Works, Bay City, Mich., recently celebrated its fiftieth anniversary by a banquet at the end of a conference of sales representatives from different sections of the United States, Canada, Cuba, and South America. William L. Clements, president, C.R. Wells, secretary and vice president, and Earnest B. Perry spoke at the banquet. They outlined the progress of the company from 1873 to the present, during which time the company grew from a small organization with a working force of about 30 operatives in a shop 75 x 100 feet, to a plant of 59 buildings 440,000 square feet of covered floor space. During the conference the representatives witnessed the testing of 200-ton locomotive crane made for the Norfolk & Western railroad. This crane which is one of the largest locomotive cranes in the world, is shown in the accompanying illustration on the following page.

Magnet for Removal of Tramp Metals

Designed solely as a safety device and therefore not to be confounded with the lifting type, the magnet shown in the accompanying illustration recently has been placed on the market by the Magnet Manufacturing Co. Milwaukee. The magnet is suspended from a suitable chain sling over a conveyor belt expressly for removing any foreign iron or steel that inadvertently may have fallen into nonmagnetic material as it flows through the chute or along a belt. The primary purpose of the device is to protect crushing, grinding and pulverizing machinery from damage that would ensue if this tramp metal entered the jaws. The essential difference between this and the ordinary lifting magnet is that in this type the current



MAGNET IS OF THE HORSESHOE TYPE

is flowing through all the time, while in the lifting magnet the flow is intermittent. That is, the current is on while the magnet is attached to a load and when the current is disconnected the load is released. The ability of the magnet to remove material buried to a considerable depth is indicated by a recent test the result of which is shown in the illustration. It is stated that the magnet was suspended 12 inches above a conveyor traveling 400 feet per minute and removed the miscellaneous pile of material shown.

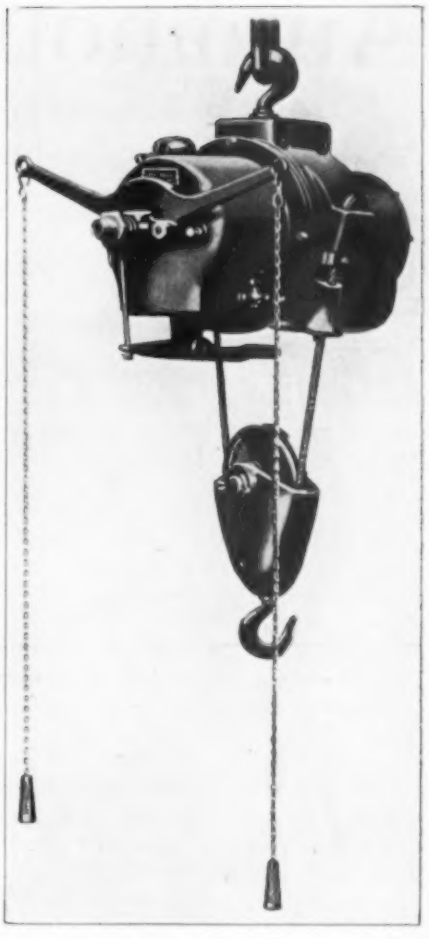
Magnet coils are wound to operate on standard voltages of 110 or 220, direct current. If necessary the magnet may be wound to operate on 500 volts direct current. The magnet poles are arranged to extend across the entire surface of the conveyor belt or chute and in a manner to attract and hold any tramp iron flowing past, whether it is on the surface or buried in the non-magnetic material.

Correction

On page 843 of the Oct. 15 issue of THE FOUNDRY a statement appears ascribing to L. H. Knapp, General Electric Co., Schenectady, N. Y., the remark that $0.115 per kilowatt-hour applied on one installation of electric core ovens. This should have read "At one plant an average of 11½ pounds of cores baked per kilowatt-hour was obtained."

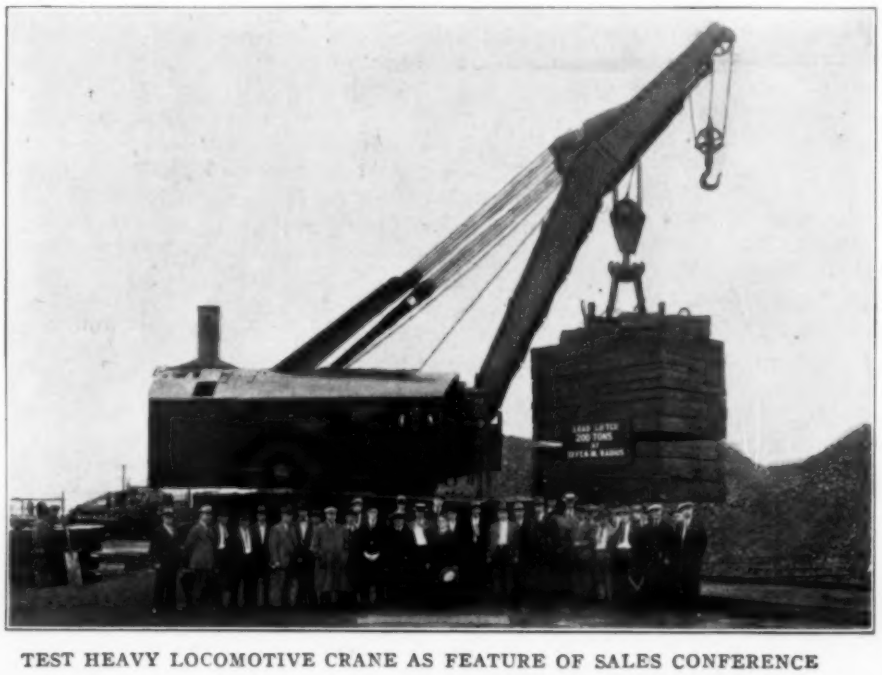
Has Automatic Brake and Throttle Control

Several novel and distinctive features characterize a new air hoist shown in the accompanying illustration and recently developed by the Ingersoll-Rand Co., New York. The hoist has a lifting capacity of 500 pounds and it is claimed that it is admirably suited for a wide range of service in a field that previously has been served by hand labor or by comparatively heavy hoists of the chain or cylinder type. Outstanding features of the hoist include: Compact design which renders it particularly desirable where head room is limited, light weight, automatic brake which it is claimed will hold the load under any condition and a graduated throttle by which the lifting and lowering speeds may be closely regulated.



AIR MOTOR HOIST HAVING 500-POUND CAPACITY

A balanced three-cylinder air motor operates in either direction without vibration at any speed or load within the rated capacity. The motor is connected to the hoisting drum through a suitable gear train. A safety stop lever closes the throttle and stops the motor should the load by any chance be raised to the top of the hoist lift. The motor and gears are enclosed and operate in an oil bath. The hoist has a lifting capacity of 500 pounds, a lifting speed of 50 feet per minute, a maximum lift of 15 feet, carries 35 feet ¼-inch wire rope, a net weight of 150 pounds and operates on any air pressure from 60 to 100 pounds. This lifting device is peculiarly adapted to foundry use. It is protected from heat and dust, it is free from vibration, and the graduated control is a desirable feature in drawing patterns, setting cores, or, lifting and closing copes.



TEST HEAVY LOCOMOTIVE CRANE AS FEATURE OF SALES CONFERENCE

Dempsey Furnace Co., 15 Park Row, New York, has acquired factory premises at 61-63 Cornelison avenue, Jersey City, N. J., where it will manufacture industrial oil burning equipment, as well as the furnaces associated with its name.

Automotive Shops Re-equip

New Projects and Purchases of Replacement Machinery Noted in Automobile Field—Sand Blast Equipment Manufacturers Experience Heavy Demand—Cupola Sales Satisfactory

SEVERAL projects are under way which will result in an extension of the automotive casting capacity available. The Ford Motor Co. has commenced the construction of an addition to its River Rouge foundry, as a part of its program of 8000 cars per day for next year, and has not as yet placed many of its equipment orders. The Cadillac Motor Car Co., Detroit, is going forward with its foundry construction plans, although the building contract has not been let, and practically all of the equipment remains to be purchased. The Saginaw Malleable Iron Co., Saginaw, Mich., is to double its present capacity. The Ferro Machine & Foundry Co., Cleveland, is installing new machinery to increase its capacity. The Stoney Foundry Engineering & Equipment Co., Cleveland, will make six small jar-ram, squeeze stripping machines for small automobile cylinders, in addition to three of a larger size and one which will handle cylinders weighing up to 280 pounds apiece, for the Ferro company. The Stoney company recently received an order for four molding machines from the Westinghouse Air Brake Co., Wilmerding, Pa. The Ferro Machine & Foundry Co. will install seven additional core ovens to be built by the F. A. Coleman Co., Cleveland. The Bonney-Floyd Co., Columbus, O., and the Holmes Foundry Co., Port Huron, Mich., have contracted with the Pangborn Corp., Hagerstown, Md. for sand blast equipment and the former will also install a dust arrester. The Foundry Equipment Co., Cleveland, has orders for core ovens from the Everett Steel Co., Everett, Wash., and seven units from the Josam Mfg. Co., Michigan City, Ind. The American Brake Shoe & Foundry Co. has purchased tumbling mills and dust arrester equipment for its Buffalo and Chattanooga, Tenn., plants from the W. W. Sly Mfg. Co., Cleveland. Sales of sand blast equipment, made by the latter firm include the Ford Motor Co., Detroit, while the Auto Specialties Mfg. Co., St. Joseph, Mich., William & Harvey Rowland, Philadelphia and the American Steel Products Co., Macomb, Ill., have purchased tumbling mills from the same manufacturer.

Eastern Market Restricted

TRADING in the eastern foundry equipment market continues greatly restricted. Some sellers state that orders over the past two weeks were lighter than in the 2-week period immediately preceding, and there appears to be little doubt but what the market generally was sluggish. An outstanding order calls for a 24-ton cupola for Leonard & Baker, Taunton, Mass., this business going to the Whiting Corp., Harvey, Ill., which also booked an order for a 9-ton cupola for the Ravena Iron Works, Ravena, N. Y. The Raritan Foundry Co., Raritan, N. J., has been a buyer of miscellaneous equipment recently, and is expected to make further purchases shortly. A large foundry is to be erected, in connection with a new plant, by the Standard Sanitary Mfg. Co., Baltimore, which recently purchased a 40-acre site in that city and is now in the market for about 3000 tons of steel for the various buildings. It is planned to have the plant in full operation within a year. The Otis Elevator Co. is reconstructing its steel foundry at Buffalo. The foundry was originally designed to handle the company's own requirements, but recently, it is understood, the company has been taking some outside casting work and by enlarging its plant will go into this business on a larger scale. The present capacity of the plant is said to be around 300 tons per month. Prices on foundry equipment continue steady, with little change expected over the next month. The American Brake Shoe & Foundry Co., New York, has purchased sand blast and dust arrester equipment from the Pangborn Corp., Hagerstown, Md. Other sales of the Pangborn company include sand blast and dust arrester equipment to the M. L. Oberdorfer Brass Co., Syracuse, N. Y.

Pittsburgh District Active

A FAIRLY active market exists on foundry equipment in the Pittsburgh area although many propositions possibly will be carried over until after the first of the year to avoid showing in inventories. Sales of molding machines have been confined to a few single installations and several large companies are about to close, their engineering departments having tabulated requirements and applied for appropriations. The placing of several large orders doubtless will take place before the present year ends by several large car wheel manufacturers and other foundry operators. The Pittsburgh Gray Iron Foundry Co., North Side, Pittsburgh, has closed on a blower manufactured by the P. H. & F. M. Roots Co., Connersville, Ind., and a large motor by the Westinghouse Electric & Mfg. Co. Cupola sales recently recorded by the Whiting Corp. include one to the American Brake Shoe & Foundry Co.; one to the Inman Mfg. Co., Amsterdam, N. Y. A few small occasional sales of wheelbarrows, riddles, etc., are noted by sellers in this vicinity. Occasionally crane and hoist purchases are arranged by foundries. For instance, the Columbiana Foundry Co., McKeesport, Pa., bought a small crane from the Erie Steel Construction Co., Erie, Pa. The Westinghouse Electric & Mfg. Co. bought a 1-ton crane for its Pittsburgh plant from the Curtis Pneumatic Machinery Co., St. Louis, and is understood to have closed on a monorail hoist and transfer crane for the same plant with a Detroit crane builder. A prospective foundry equipment purchaser is the W. J. Early Sons Foundry Corp., recently incorporated in Delaware with a capital of $500,000 to take over and expand the business of W. J. Early & Sons, 812 Sarah street, Pittsburgh, foundations already being laid for a new foundry.

Chicago Company Sells to French Firm

ANDRE CITROEN, the Henry Ford of France, has reached across the Atlantic to obtain sand mixers for a new foundry he has constructed in Paris. He has purchased two 6-foot mixers from the National Engineering Co., Chicago. Other sales by the National Engineering Co. include a sand mixer to the Rockford Malleable Iron Works, Rockford, Ill., and a similar machine

to the Carnegie Steel Co. for its Braddock, Pa., works. The Whiting Corp., Harvey, Ill., has sold two batteries of tumblers, 36 x 72 inches, to the American Car & Foundry Co., and a cupola to Kohler Co., Kohler, Wis. The Nugent Steel Castings Co., Chicago, is to build a two-story 40 x 120-foot, reinforced concrete pattern storage building with provision for a third story, and has retained Frank D. Chase, Inc., as engineers. Makers of foundry equipment appraise business as fair, with no great prospects of marked improvement. The Allis-Chalmers Mfg. Co., and the Milwaukee Steel Foundry Co., both of Milwaukee, have purchased sand blast equipment from the Pangborn Corp., Harvey, Ill. The former firm also will install a dust arrester. The General Aluminum & Brass Mfg. Co., Detroit, has purchased a water polishing mill from the W. W. Sly Mfg. Co., Cleveland.

Active Market in Prospect

WHILE a fairly active foundry equipment market is in prospect in New England for the late fall, the situation at present is dull. Several foundries or foundry additions under construction are nearing the point when equipment will be bought. One of these is the H. & B. American Machine Co., Pawtucket, R. I., for which a fairly large list of equipment is to be placed. Several New England foundries are actively in the market for electric furnace equipment and crane manufacturers report more foundry prospects on their books than usual. Recent sales include a mixer and a sand separator to the Hunt-Spiller Corp., Boston, an electric riddle and other equipment to the Walworth Mfg. Co., Boston, a sand separator to the Manufacturers Foundry Co., Waterbury, Conn., and a 25-ton crane to the General Electric Co., Lynn, Mass. The Randolph Foundry Co., Randolph, Mass., is in the market for a sand blast barrel and Taylor & Fenn Co., Hartford, Conn., is in the market for a sand separator. The Milford Iron Foundry, Milford, Mass., is being changed over to manufacture plumbing supplies and some of its equipment will be offered for sale. The Fremont Casting Co., Worcester, Mass., has started work on a 40 x 100-foot addition which is to be used as a pattern shop and office. H. A. Davis is the manager.

What the Foundries Are Doing

Activities of the Gray Iron, Malleable, Steel and Brass Shops

The Saco Lowell Shops plans a 2-story brick foundry addition at Lowell, Mass.

Midwest Foundry Co., Cleveland, was incorporated for $10,000 by J. Virgil Cory and W. C. Bleckmore.

Taylor Bros., Vankleek Hill, Ont., is in the market for foundry equipment including presses.

Machinery is being installed for the Gem Foundry in the building recently completed for it in Hart, Mich.

Springfield Brass Co., 821 West Main street, Springfield, O., plans a 1-story, 30x30-foot, brick and concrete foundry costing about $10,000.

Standard Sanitary Mfg. Co., Pittsburgh, has let bids for constructing three buildings at Tiffin, O.

Toledo Ferrous Products Co., Toledo, O., was incorporated for $500 by Clarence R. Teeter and Charles M. Bulger.

Columbia Iron Foundry has been incorporated for $25,000 by George Grosehalp, 744 East Westmoreland street, Philadelphia.

Construction contracts have been let by the American Brake Shoe & Foundry Co. for a plant at North Kansas City, Mo.

Supreme Foundries, Ltd., Pont Rouge, Que., is asking for various items of equipment including squaring shears, etc.

Nutley Foundry Co., Nutley, N. J., plans to rebuild its foundry recently damaged by fire. It is a manufacturer of gray iron castings.

Contracts have been let for the construction of a $25,000 foundry addition to the North Milwaukee Foundry Co., North Milwaukee, Wis.

Detroit Foundry Co., 2642 East Grand Boulevard, Detroit, Frank Bromley, president, plans a 1-story addition at Vonant and Christopher avenues, Hamtramck, Mich.

Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., is soon to let contracts for constructing a 1-story 40x50-foot addition costing about $40,000.

The Transue & Williams Steel Forging Corp., Alliance, O., reports net earnings for the nine months ended Sept. 30, 1923, amounting to $287,000 after allowance for taxes.

The Keeler Brass Co., Grand Rapids, Mich., operator of a brass foundry, has taken out a building permit for construction of $134,000 factory.

Bids are being taken on construction of a 2-story, 160 x 500-foot, $1,000,000 foundry building at 4100 South Kedzie avenue, for the Crane Co., Chicago.

Bostwick Stove Works, Lapeer, Mich., recently was damaged by fire with loss of about $40,000. The conflagration originated in the cupola of the foundry unit of the stove works.

Ampco Iron Co., Springfield, Mo., is having plans prepared for a 1-story foundry to cost from $40,000 to $50,000 completed, to be constructed at El Paso, Tex.

Vilter Mfg. Co., 872 Clinton street, Milwaukee, operator of a gray iron and brass foundry, has received permit to build a $25,000 shop for pipe making.

Thermo Automatic Oil Burner Corp., Buffalo, N. Y. was incorporated for $200,000 by W. L. Higgins, 20 West Utica street, to manufacture oil burners.

F. R. Patch Mfg. Co., Rutland, Vt., manufacturer of machinery, plans erection of a 2-story, 90 x 200-foot steel shop. The company also manufactures gray iron and brass castings.

Reynolds Oil Burner Co., Ltd., Toronto, Ont., has been incorporated for $40,000 to manufacture and deal in oil burners and other heaters, by Lyman G. Reynolds, John A. Marvin and James R. Roaf.

Keystone Driller Co., Beaver Falls, Pa., operator of gray iron, steel, brass and aluminum foundries, plans a $15,000 addition to its plant at Eighth avenue and Seventeenth street.

Rich Steel Products Co., Battle Creek, Mich., was damaged by fire recently with loss of about $150,000. The company manufactures automobile engine parts, twist drills, etc., and operates an aluminum foundry.

The North Milwaukee Foundry Co., North Milwaukee, has increased its capitalization from $40,000 to $100,000 to permit expansion of its facilities for light and medium weight steel castings. This was previously reported to be for a gray iron foundry. This report was in error.

Coosa Pipe & Foundry Co., Gadsden, Ala., has awarded contracts for construction of a $75,000 plant increasing its capacity by from 20 to 25 per cent. It will be equipped with a new steel cupola room, etc.

American Chain Co., Albermarle street, York, Pa., plans erection of a $65,000 addition to its plant for manufacture of automobile bumpers the building to be next to its present malleable iron foundry.

Weir Stove Co., Taunton, Mass., manufacturer of heating ranges and stoves, furnaces has begun construction of a 140x160-foot foundry, 1-story, costing approximately $65,000. Two other buildings recently were added.

Garden City Foundry Co., Chicago, doing a gray iron foundry jobbing business, has been taken over by the Mortimer Foundry Co., that city, the operations of the Garden City company continuing largely unchanged.

Operations have been started in the Standard Semi-Steel Foundry Co., Keokuk, Iowa, in the plant recently completed. Charles Wilkes heads the new company operating the plant which manufactures castings for railroad use.

William J. Collins has purchased land for the William J. Collins Foundry Co., Inc., Milford, Mass. Three buildings will be built, the main one being 50 x 70 feet. Equipment will be required to outfit the company.

Construction will start about Feb. 1 on a $100,000 plant addition to the National Stove Co. plant at Lorain, O., subsidiary of the American Stove Co., St. Louis. Thomas Rath is superintendent of the Lorain plant which manufactures gray iron castings.

A warehouse, 50x100 feet, is being constructed by the Algoma Foundry & Machine Co., Algoma, Wis., manufacturer of gray iron, brass and aluminum castings, to connect the present foundry with the machine shop and painting departments.

The Fremont Casting Co., Worcester, Mass., has started construction of a 40x100-foot addition to be used as a pattern shop and office. The company is a jobbing foundry, but makes

a specialty of textile machine castings. H. A. Davis is the manager.

Takefman & Goldblatt, Ltd., Hamilton, Ont., has been incorporated for $400,000 to manufacture and deal in metals and to carry on a general foundry business. Incorporators are Frederick H. McCallum, Robert Blair and Thomas A. Simpson.

Electric Steel Castings Co. was organized recently as a sales division of the Electric Steel Products Co., Turners Falls, Mass., operator of a steel foundry. The plant of the latter company has been enlarged with the addition of new equipment including a No. 2 mixer, standard radial sand blast barrel, annealing oven, etc.

Damascus Steel Casting Co., New Brighton, Pa., previously operating as a partnership, was incorporated recently for $200,000 by Charles Capper, Wilkinsburg, Charles H. Capper, New Brighton, and Florence C. Peterson, Wilkinsburg, Pa., to manufacture and sell iron and steel and castings.

West Haven Foundry Co., 27 Kimberly avenue, West Haven, Conn., is building a new foundry to be completed about Dec. 1, to be equipped for the manufacture of brass, bronze, aluminum, nickel, silver and all kinds of nonferrous castings. The temporary office, in charge of W. G. Shutter, is at 17 Lester street, West Haven. The company will engage in a general jobbing business.

A $500,000 Delaware charter has been taken out by the W. J. Early Sons Foundry Corp., Pittsburgh. The charter stipulates 5000 shares 7 per cent nonvoting, accumulating preferred stock of $100 par value and 16,000 shares voting common stock of no par value. The old company has been operating in Pittsburgh for 34 years. John N. Early, president, has developed a heat treatment process for a product which contains no alloys.

Special castings and electric alloy steel sucker rods are expected to be added to the output of the Texas Steel Mills, recently formed with John H. Kirby as president. The company will use the remodeled plant formerly occupied by the Armstrong Steel Co., South Fort Worth, Texas. The mill will commence manufacture of reinforcing bars, merchant bars and small stuctural shapes as soon as alterations and equipment are completed and installed.

New Trade Publications

LIGHT REFLECTORS—Several leaflets published by the National X-Ray Reflector Co., Chicago, show the advantages gained by intensifying illumination with the use of reflecto

SHOT BLASTING—A folder published by the Pangborn Corp., Hagerstown, Md., contains information concerning dustless sandblasting by the use of steel grit and shot.

MACHINERY—An 8-page folder listing various pieces of machinery such as boring machines, shapers, lathes, etc., has been issued by the E. L. Essley Machinery Co., West Washington boulevard, Chicago.

POWER HAMMERS—A small folder describing power hammers recently was issued by the Central Machine Works Co., Minneapolis. Features of construction, operation, lubrication, etc., are pointed out.

RECORDING INSTRUMENTS—The use of graphic recording instruments in boiler and generator rooms, substations, meter departments, etc., is explained in a bulletin issued by the Esterline-Angus Co., Indianapolis. Several illustrations of their applications are given.

GRINDING MACHINES—Bench and floor grinders for light and heavy duty are described in a 16-page bulletin issued by the Hisey-Wolf Machine Co., Cincinnati. Some of the features discussed are ball bearings, special starter, guards, rests, etc.

LUBRICATING DEVICES—Sight feed, snap lever, slide and screw top oilers, and grease cups are illustrated in a folder issued recently by the Penberthy Injector Co., Detroit. Specifications and other descriptive matter is included.

OPTICAL PYROMETERS—Optical pyrometers are discussed and their operating principles described in a 15-page catalog published by the American Kreuger & Tool Corp., 522 Fifth avenue, New York. Considerable technical data and a correction table for deviation in black bodies are given.

JACKLIFTS—The Lewis-Shepard Co., Boston, has published a circular describing jacklifts, wood and metal leg platforms, single lifts, self-loading trucks and stackers. Each machine is pictured separately to show its application to plant production.

CONTROLLER VALVE—Information regarding controller valves for air and oil, air and gas, and air, gas, water and steam is included in bulletin 319, published recently by the Bristol Co., Waterbury, Conn. Descriptive matter concerning temperature controllers and recording pyrometers also is given.

DRIVE SCREWS—The Parker-Kalon Corp., 352 West Thirteenth street, New York, has issued a folder describing the use of hardened metallic drive screws for use in attaching name plates and other similar articles which require permanent fastenings.

TACHOMETERS—Recording, indicating and combination unit tachometers are illustrated and described in a bulletin published recently by the Bristol Co., Waterbury, Conn. The field of usefulness of each instrument is explained in detail and diagrams showing the proper methods of installation and connection are presented.

PNEUMATIC RIVETERS—An illustrated folder recently issued by the Hanna Engineering Works, Chicago, describes a hydraulic riveter which may have single, double, triple or 6-pressure cylinders. A table lists the capacity in tons, and the diameters of the large, small and push back cylinders.

ELECTRIC SOLDER POT—J. D. Wallace & Co., Chicago, recently has issued a circular describing and illustrating an electric solder pot with automatic heat control. Some of the features of the device are pointed out and the principles of the heat regulator are explained.

LABOR SAVERS—A catalog of foundry labor saving devices is being issued by the Adams Co., Duquesne, Iowa. Different types of molding machines and small equipment are illustrated and described. The back of the book is devoted to the subject of cast scratch plates, their use and the method of making them.

PIG IRON—The Bethlehem Steel Co., Bethlehem, Pa., has published a book describing the composition, manufacture and uses in foundry work of nickel-chromium bearing pig iron. Among the uses for which the iron is recommended are pump castings, cylinder liners, cylinder heads, retorts, etc. A large number of illustrations of finished products containing the iron are shown.

PNEUMATIC RAMMERS—Applications of pneumatic rammers to the manufacture of concrete building blocks and other articles such as sewer covers, chimney caps, window sills, curbing, etc., are pointed out in a folder issued by the Chicago Pneumatic Tool Co., New York.

ELECTRIC HOISTS—The Detroit Hoist & Machine Co., Detroit, has issued a 25-page illustrated catalog devoted to hoists, monorails, cranes and winches. Illustrations show the applications of these hoists to the various fields of industry.

SAND CUTTER—A self-propelled electric sand-cutting machine is described in an illustrated bulletin recently published by the American Foundry Equipment Co., 366 Madison avenue, New York. The machine is shown in different positions and in actual operation. Features such as frame, wheels, cutting blades, cutting cylinder drive, travel drive, etc., are briefly discussed.

ELECTRIC FURNACES—Data pertaining to features, design, parts, operation, service, etc., of electric furnaces are given in a comprehensive illustrated catalog published by the Pittsburgh Electric Furnace Corp., Pittsburgh. Information is given regarding calculation of furnace size for a desired output. Photographs show furnaces in use, charging devices, control boards, etc.

BRUSHES—Motor and generator brushes are described in a folder issued by the United States Graphite Co., Saginaw, Mich. A table of brush characteristic shows the specific resistance, carrying capacity in amperes per square inch, permissible peripheral speed, scleroscope hardness, transverse breaking strength, contact drop in volts and coefficient of friction for various grades of brushes.

ANNEALING FURNACES—Rotary and regenerative car-type electric annealing furnaces are illustrated, and their important characteristics pointed out, in two folders which are being distributed by the George J. Hagan Co., Pittsburgh. Application of the rotary furnace to the manufacture of automobile parts is discussed in one of the bulletins. Construction of the car-type furnace is shown by means of a diagram and photographs.

HEAVY DUTY MOTORS—The Reliance Electric & Engineering Co., Cleveland, has published a 32-page illustrated catalog in which various stages in the construction of a heavy duty direct current motor are described. Subassemblies, such as fields, armature, etc., and their parts, are shown separately. Several diagrams are presented to illustrate the various parts of the motor and tables give ratings and dimensions.

FOUNDRY MACHINERY—A molding machine which jolt-rams the mold, rolls it over, and draws the pattern is described in a bulletin issued by the American Foundry Equipment Co., 366 Madison avenue, New York. Important savings effected by the machine are the making of the cope and drag together, no compressed air or metal plates required, and the obviation of the necessity for the services of a skilled molder.

ELECTRIC TRACTORS—The Mercury Mfg. Co., 4118 South Halsted street, Chicago, recently has issued a 6-page folder which illustrates the various features of an electric industrial tractor equipped with new type of drive. Construction details are shown in the illustrations of subassemblies of the machine. Other illustrations show the tractors in actual service indicating their wide range of usefulness.

OIL BURNERS—A folder published by the Anthony Co., Long Island City, N. Y., contains a brief description of the principles and operation of an oil burner whose action is independent of fluid impact the mixing of the air being accomplished by a definite liquid pressure which forces the fuel into the nozzle. An explanation of the ability of the burner to fix the intensity, length, spread, velocity, volume and quality of the flame is offered.